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National Contingency Plan Phase II Activities: A Problem Analysis & Decision Framework for Understanding & Evaluating Oil Pollution Threats from Sunken Ships Off California

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ABSTRACT 299879:

The National Contingency Plan (NCP) provides an assessment framework through which to manage pollution threats in the United States. Although the NCP delivers an assessment framework for evaluating Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) threats through formalized Site Assessments, Feasibility Studies, and Remedial Investigations, the NCP falls short of delivering a similar iterative process through which to evaluate non-emergent oil pollution threats. Recent experience with two historical wrecks in California (SS MONTEBELLO and M/V FERNSTREAM) suggest an opportunity to develop a problem analysis and decision framework enabling assessment/response (A&R) teams to evaluate more fully the nature of a problem, as well as the relative efficacy of alternative courses of action available to the Federal On-Scene Coordinator (FOSC). Using those two experiences as case studies, promising practices are distilled and adapted thru a formal policy analytic process to develop a problem analysis and decision framework for non-emergent oil threats. The intent is to bolster the utility of the NCP's Operational Response Phases for Oil Removal with emphasis on Phase II activities, and to provide FOSCs, Area Committees and Regional Response Teams a more robust evaluation tool.

INTRODUCTION:

The United States Coast Guard (USCG) leads marine spill responses stemming from shipwrecks and other sources. Michel et al (2005) estimated that over 8,500 potentially polluting wrecks may exist worldwide with an estimated 2.5 to 20.4 million tons oil cargo and/or fuel or bunkers on board. Over the past 10-years, numerous recent emergency responses and assessments of shipwrecks occurred within waters subject to the jurisdiction of the U.S. For example, the active pollution threat presented by SS JACOB LUCKENBACH over a period of decades impacted an estimated 51,000 birds and eight sea otters, prompting lightering operations of 2,380-barrels of heavy bunker fuel from the wreck. Approximate mitigation and restoration costs totaled over $40 million (Luckenbach Trustee Council, 2006; NOAA, 2013b). Had the nature of the problem been explored earlier and more fully, a less-impacting and more cost-effective approach may have been realized.

Interest in the topic of potentially polluting shipwrecks continues to mount since the LUCKENBACH response. Such interest prompted efforts to systematically identify, investigate, and potentially remove oil from wrecks before they begin to leak. In 2010, the National Oceanic and Atmospheric Administration (NOAA) was funded to identify and prioritize potentially polluting wrecks in U.S. waters, including the Great Lakes. The resultant Remediation of Undersea Legacy Environmental Threats (RULET) report series (NOAA, 2013) narrowed 20,000 sunken vessels known in U.S. waters to 107 that may pose a substantial pollution threat based on a variety of factors. The report and 87 associated risk assessments provide historical and archival data for FOSC visibility, consideration, and possible action.

Four of the risk assessments are specific to California waters (see Table 1). The prioritized RULET listing provides an opportunity for the USCG and interagency partners to address these potential pollution threats in a more proactive, methodical, and cost-effective manner than previously, but how FOSCs choose to use and act on the information may vary from site to site and from region to region. Case studies surrounding SS MONTEBELLO and M/V FERNSTREAM illustrate those realities, as well as the need for a proactive, coordinated, and methodical problem analysis and decision framework.

Conceptualizing the nature and extent of a problem is vital to informing possible future actions and their relative efficacies. Whereas the NCP achieves an effective solution to conceptualizing CERCLA threats by articulating a robust evaluation framework, no formal guidance exists for non-emergent oil threats outside of the NCP's Operational Response Phases for Oil Removal; specifically, the three-step process outlined in Phase II, "Preliminary assessment and initiation of action". The recently published National Response Team's (NRT) Abandoned Vessel Authorities and Best Practices Guidance attempts to fill this gap, but falls short of providing the desired level of detail necessary for a complete assessment. In the absence of more definitive and comprehensive national-level guidance for assessments related to non-emergent oil threats, FOSCs, USCG Sectors, and associated Area Committees may benefit from a more deliberate problem analysis and decision framework for evaluating RULET targets. This problem analysis framework is based on promising practices from assessment of the SS MONTEBELLO and M/V FERNSTREAM and adapted using Bardach's (2012) Practical Guide for Policy Analysis.

METHODOLOGY:

The methodology involved three primary research steps: 1) Participation in both case studies during assessment and response activities; 2) Literature review of ongoing academic and professional discussions related to potentially polluting wrecks and policy and problem analysis processes; and 3) Development of the proposed framework using current trends and realized needs. The remainder of the paper is divided into two parts. First, SS MONTEBELLO and M/V FERNSTREAM case studies are presented as examples of proactive wreck assessment. Finally, the proposed problem analysis and decision framework for addressing non-emergent oil threats, such as RULET targets, is presented.

RESULTS/DISCUSSION:

Case Study: Assessment of SS MONTEBELLO:

The tankship SS MONTEBELLO was built in 1921 and sunk by a Japanese submarine 6.5-miles off Cambria, California, on the morning of December 23, 1941. Although she was loaded with nearly three-million gallons of Santa Maria crude oil, no substantial leakage was ever reported in the vicinity after she sank. Several visual assessments including remote photography and submersible dives confirmed her identity and relatively intact condition, sitting upright in nearly 900-feet of water.

Longstanding concerns prompted the USCG, the State of California's Office of Spill Prevention & Response (OSPR), NOAA, and others to form the MONTEBELLO Task Force to evaluate the possibility of the wreck's substantial pollution threat. In 2011, USCG Sector Los Angeles/Long Beach (LA/LB) accessed the Oil Spill Liability Trust Fund (OSLTF) to perform an in-water assessment to verify the threat. Looking across the Task Force and Sector LA/LB's activities, the overall strategy shows three distinct stages: 1) Preliminary Threat Evaluation, 2) In-water Wreck Assessment, and 3) Mitigation Alternatives Evaluation.

The Preliminary Threat Evaluation stage compiled available historic information to determine what could be learned about the pollution threat and to identify and prioritize critical data gaps that might be filled opportunistically if funds became available. Information included facts about the ship and its cargo, computer model runs of potential release scenarios to include oil weathering and trajectories, and resource-at-risk assessments. The Task Force included several workgroups and subgroups, each with specific tasking. For instance, the Environmental Assessment workgroup had distinct subgroups that focused on more specific disciplines including oil fate and transport, ecological resources-at-risk, cultural resources-at-risk, and economic resources-at-risk. Some of the key questions at the time included:

- What is the ship's structural condition?
- What's the most likely leak scenario?
- From where is a leak likely to occur (e.g. tank tops, rivets, piping and/or venting)?
- Under what conditions might she reasonably release oil (corrosion, structural failure, local seismicity)?
- What are the chemical and physical properties and condition of the oil (e.g. viscosity, pour point, stratification)?
- If SS MONTEBELLO still has substantial oil on board, what ecological, cultural and/or economic resources might be at risk if there is a long-term/chronic release? A short-term/catastrophic release?
- Based on site conditions and relative risks to sensitive resources (ecological, cultural, economic), when might be the best time for on-scene assessments and/or mitigation efforts, if needed?

The Preliminary Threat Evaluation resulted in sufficient information for USCG Sector LA/LB to determine that a detailed in-water assessment of SS MONTEBELLO was warranted because she posed a substantial pollution threat. Funds from the OSLTF were then accessed to verify that threat. If verified, funds would remain available for remediation activities.

The In-water Wreck Assessment stage employed remotely-operated vehicles (ROVs) to: 1) fill data gaps identified previously, 2) further assess the condition of the ship and 3) perform non-invasive and/or invasive tank assessments to verify the pollution threat and provide critical information for next steps, if needed. The effort included coordination with the State Historic Preservation Officer (SHPO) to address any concerns related to Section 106 of the National Historic Preservation Act (NHPA) and was guided, in part, by a maritime heritage expert from NOAA familiar with the wreck. Expected outcomes included the locations and estimated volumes of tanks containing substantial quantities of oil, oil analyses for chemical and physical properties, as well as dispersibility and fingerprinting, vessel surveys featuring high definition video documentation, and corrosion analyses of hull plating. Prior to the assessment's completion, initial plans were developed to evaluate mitigation alternatives in the event that substantial oil volumes were found on board. However, this $3.5 million effort ultimately determined that SS MONTEBELLO no longer posed an imminent and substantial threat, so the case was closed.

The Mitigation Alternatives Evaluation stage sought to determine the proper course of action to mitigate the pollution threat, if needed. As envisioned, recommendations to the FOSC would be provided by teams of subject matter experts focused on evaluations of: 1) oil properties and volume, 2) the ship's condition (structural and corrosion status), and 3) the state of available salvage tools for deepwater lightering operations. Teams were to develop initial recommendations based on available information, as well as their best professional judgment considering both the "imminent" and "substantial" nature of the pollution threat. Initial recommendations would then be vetted through numerous Special Teams under the NCP and other expert teams to aid in the development of a joint final recommendation(s) to the FOSC that would include no action, monitoring, passive remediation, or active remediation options.

Considering the SS MONTEBELLO Task Force's decision framework more abstractly, they appeared to follow a series of cleverly designed steps. The Task Force initiated actions with an iterative evidence gathering campaign, which defined the initial problem and associated data and information gaps and then attempted to refine them. In light of those gaps, and in consideration of a status quo alternative, Sector LA/LB elected to conduct an in-water assessment for more evidence. The succeeding stage (mitigation alternatives evaluation) would have presented to the FOSC a spread of response alternatives where one or a combination of several would be selected for implementation for the remediation stage. Each stage of the MONTEBELLO Task Force's efforts shows promise for application during future similar cases involving the evaluation of non-emergent oil threats.

Case Study: Assessment of M/V FERNSTREAM:

The cargo ship M/V FERNSTREAM was a 416-foot Norwegian-flagged, diesel-powered vessel built in Sweden in 1949. Shortly after departing for Manila, Philippines, it collided with SS HAWAIIAN RANCHER in San Francisco Bay on the morning of December 11, 1952. She carried 3,000-tons of soybeans and general cargo, and an estimated 12,500-barrels of marine diesel as fuel (NOAA, 2013c). The USCG Marine Board of Investigation found that she was struck on the port side, "just abaft the bridge… [penetrating] the hull at the after part of the engine room, damaging the watertight bulkhead to No. 4 hold" (USCG, 1953). She then sank within 37-minutes, coming to rest on her side in 152-feet of water.

Following release of the RULET Risk Assessment package (NOAA, 2013c), Sector San Francisco established the FERNSTREAM Task Force and applied a modified version of the MONTEBELLO Task Force's three-stage approach, beginning with a Preliminary Threat Evaluation. Some of the key information that was not known at the time included:

- Precise location of the ship
- Condition, orientation (upright, on her side, or inverted)
- Volume, location and configuration of fuel tanks
- Actual volume of fuel on board prior to departure
- Present volume of remaining oil on-board (if any)
- Degree of hull burial in sediment and slope stability

Archived charting information from NOAA as well as ship's plans obtained from Norway provided the likely location of M/V FERNSTREAM and the tanks thereon. Subsequent NOAA sonar imagery confirmed her precise location, orientation, and general condition. Imagery indicated she was no longer on her side and may have suffered additional structural damage than what was described originally. The FERNSTREAM Task Force then identified data gaps and a spread of initial survey assets to fill those gaps. Since then, additional survey work indicated that the structural damage is severe enough to limit the possibility of a pollution threat, so appropriate next steps are under consideration.

The FERNSTREAM Task Force succeeded thus far in their application of problem analysis basics. The Task Force began with a loose definition of the problem defined amongst a team of stakeholders holding different, yet complimentary views. A coordinated effort then followed with an exhaustive search for evidence to better inform the problem definition as well as their collective understanding of the situation. During Preliminary Threat Evaluation the Task Force developed a technical subgroup tasked with exploring creative and cost efficient alternatives for conducting in-water evidence collection. Moving forward, any alternatives eventually developed based on the in-water evidence collection will likely go through a series of assessments to project various impacts to public and responder health and safety, environmental effects, and economic impacts. Any potentially invasive activities will be developed in consideration of the historic elements and in consultation with the SHPO.

What emerges from the two case studies is a general process for analyzing problems and constructing an iterative framework upon which informed decisions may be made. In light of congruence between the promising practices shared by both Task Forces and the elements of a formal policy analytic process, the next section considers those two paradigms, coalescing them into a problem analysis framework for evaluating non-emergent oil threats to bolster the utility of the NCP's Operational Response Phases for Oil Removal; specifically, Phase II, "Preliminary assessment and initiation of action", and to provide FOSCs, Area Committees and Regional Response Teams a more robust evaluation tool.

PROBLEM ANALYSIS FRAMEWORK FOR NON-EMERGENT OIL THREATS:

Whereas the NCP achieves an effective solution to conceptualizing CERCLA threats through a robust evaluation framework, as well as guidance for conducting those activities, no formal guidance exists for non-emergent oil threats with few exceptions. The NCP's three step process for a Phase II preliminary assessment falls short of delivering the level of insight needed to evaluate fully the magnitude and severity of a non-emergent oil threat. The NRT's Abandoned Vessel Authorities and Best Practices Guidance presents a partial framework leading straight to action plan development without providing assessment tools for threat factors and projected outcomes. The proposed six-step framework, when paired with other oil spill analytic tools, may provide Regional and Area Committee-level A&R teams with the means to make concise, compelling, and comprehensive recommendations to FOSCs.

Step One: Defining the Problem

The importance of problem definition is three-fold: 1) it establishes a reason for initiating a project, 2) it provides focus for evidence gathering, and 3) it allows clear articulation of the issues to senior decision-makers, elected officials, and the public. Problem definition is and must be an iterative process. Mutual understanding of the problem will evolve as more evidence is collected and evaluated. An A&R team may assume that the primary problem resides in one area of a shipwreck and later conclude the problem resides elsewhere on the same wreck, or does not exist at all. The key is to continually make available the updated problem definition to the A&R team members, so the FOSC can leverage team expertise and effectively engage team assets and/or source federal funds, if needed.

Both SS MONTEBELLO and M/V FERNSTREAM Task Forces started with attempts to define the problem based off a rough characterization of what was known, the associated uncertainty, and data gaps. The uncertainty and data gaps then focused subsequent evidence-gathering activities increasing definition and confidence in the problem's overall scope.

Step Two: Evidence Collection & Analysis

Information commingled meaningfully can change the way a problem is perceived. Building a rigorous evidence portfolio that informs our perception of a problem requires a substantial investment in time and strategic thinking to optimize data sources. Evidence collection should start as early as is practicable, consider potential time constraints, and be divided into three conceptually distinct sub-steps (Nathan, 2000).

The first sub-step occurs at the outset of a project (the baseline period) and is considered the traditional phase of evidence collection led by the problem definition. The second sub-step occurs once activities commence (the "in-program" period), which may or may not resolve known data gaps and may identify additional gaps. The third sub-step occurs after activities conclude (the post-program period) and may last for an indefinite time period to confirm whether the selected alternative was effective.

Both the MONTEBELLO and FERNSTREAM Task Forces conducted evidence collection to better define their respective problem, though at differing levels of complexity. In both cases, initial efforts capitalized on team members' technical capabilities to both develop and articulate the value of the evidence collected. For example, during the initial FERNSTREAM Task Force meeting, a concerted effort was made to focus team evidence gathering rather than jumping to potentially speculative mitigation tactics. Evidence collection was then delegated to partner agencies with relevant technical expertise that would exhaust all relevant sources. The result optimized the use of information sources as distant as Norway and as near-by as a locallybased NOAA bathymetric survey team. NOAA's sonar data provided an updated status on the condition and orientation of M/V FERNSTREAM, prompting questions about the degree of present damage and possibly decreasing the likelihood of the pollution threat. Always an iterative process, the Task Force used the evidence to further refine the problem definition initially developed in step one.

Based on the evidence collection efforts from both Task Forces, the establishment of an evidence collection unit or other distinct technical team to focus on specific case aspects as part of the larger assessment/response effort is recommended. Furthermore, fiscal austerity necessitates considering creative and cost-effective alternatives to accessing federal funds, such as seeking availability of partner agencies with complementary technical and operational assets that can appropriately fill data gaps.

Step Three: Designing Response Alternatives

Response alternatives, or "alternatives", articulate the different ways in which something can be accomplished. An alternative could be as narrow as one of several individual tools used to accomplish a task, such as subsurface surveys, or could be a broader package encompassing an entire remediation strategy. The key for A&R teams is to create enough conceptually distinct and reasonable alternatives that lead to a useful and well-reasoned choice.

As the A&R team progresses through the problem analysis framework, alternatives may be discovered, deleted, or combined. Sometimes alternatives are novel, but in most cases they involve the re-application of previously-used approaches for similar cases. Defining alternatives requires identifying the appropriate scale relative to the objective(s) and the appropriate characteristics with which to effectively distinguish one alternative from another. Alternatives that differ incrementally may be difficult to distinguish from each other whereas alternatives differing too widely may be more challenging to evaluate/compare.

A clear example stems from M/V FERNSTREAM wherein part of the initial problem involved an incomplete understanding of the vessel's condition and extent of damage. To bridge this knowledge gap, the Task Force listed and evaluated several alternative investigative tools grouped naturally into cost categories from most to least expensive, including a variety of subsurface survey tools such as multibeam sensors, side-scan sonar, ROVs, and divers available either through partnering agencies or hired with federal funds such as from the OSLTF. Alternatives requiring substantial federal funding were eliminated, and the remaining alternatives were explored for their feasibility.

The FERNSTREAM Task Force exploited lessons learned from the SS MONTEBELLO assessment, but also crafted alternatives unique to their circumstance. Adapting a previously used alternative may be worthwhile if, for instance, the A&R team understands why the alternative was selected previously, what other competing alternatives were not selected, how the selected alternative evolved through the process, and how the alternative achieved response goals. Essentially, the team must answer two key questions: 1) what do we seek to accomplish? and 2) what tools are the best ones available to meet the challenge? Merely selecting an alternative because it was previously labeled a "best practice" may have far-reaching negative consequences absent any context. It is also important to note four pitfalls that were avoided successfully during the SS MONTEBELLO and M/V FERNSTREAM assessments:

1. Premature decision-making: Subjectively favoring one alternative over another at the outset, before all pertinent information is gathered. Doing so may hinder proper consideration of other viable (and potentially more robust) alternatives.
2. Over-emphasis on past experiences: Characterizing responses as overly similar in that all parts of the problem are the same and thus all previous solutions should be the same. The result stems from incorrectly characterizing the problem and miss-applying familiar (but not necessarily effective) solutions.
3. Loss of good ideas: Not capturing the full spectrum of brainstormed alternatives. Many effective solutions may be lost either because of the sheer volume of ideas discussed, or because they did not appear relevant when first introduced.
4. Neglecting to re-consider alternatives as circumstances change: The alternatives evaluation process is an iterative one. Conditions of uncertainty are likely to change and the issues/problems become more clearly defined, which may then require consideration of alternatives either not developed or previously discarded.

Step Four: Articulating Evaluative Criteria

Evaluative criteria are standards used to distinguish one alternative as better than another by projecting and assessing outcomes and not necessarily means (Bardach, 2012). It is important to establish criteria after developing alternatives and before projecting outcomes from each alternative to reduce the amount of bias for or against any single alternative. It is also important to prioritize criteria, weighting the relative importance of each. If outcomes from one alternative satisfy many low priority criteria and another alternative satisfies a few high priority criteria, then the latter may be preferred depending on how criteria are weighted.

Kutchin and Hereth (1999) articulated a "Best Response" model as a validated approach to judging a spectrum of response activities. In addition to the first three elements of the model, a few others are suggested that A&R teams may consider when developing their own evaluative criteria for non-emergent pollution threats.

- Safety: A feasible alternative must not jeopardize public and responder health and safety. If it might, then those hazards must be mitigated or otherwise managed to minimize risk.
- Meets the "target point": A feasible alternative by itself or in combination with others must achieve one or all of the goals set by the A&R team. Second to safety, this is one of the most important criterion.
- Natural Environment: A feasible alternative should cause less overall environmental harm than an uncontrolled, substantial release of pollutant, fully considering case-specific information (e.g. oil type and persistence, spill durations, seasonality and resources at risk, etc.) and any unavoidable impact should be minimized to the greatest extent.
- Economic Impact: A feasible alternative should not impact property or commercial and recreational activity and any unavoidable impact should be minimized to the greatest extent.
- Legality: A feasible alternative must not violate constitutional, statutory, or other common law rights.

- Political acceptability: A feasible alternative should be palatable politically and minimize opposition while garnering support. To facilitate this, consider engaging stakeholders in a discussion of the alternatives considered and selected.
- Improvability: If an alternative is found to underperform during implementation, there is opportunity to improve upon the original concept thru adaptive modification or engaging innovative expertise. This criterion is vital if an alternative must be implemented under conditions of substantial uncertainty.
- Cost Efficiency: A feasible alternative achieves desired ends while minimizing overall costs.

Step Five: Describe the Outcomes

Whereas alternatives are possible courses of action and criteria are standards by which alternatives are evaluated, outcomes are the realistic projections of what an alternative will accomplish under each specified evaluative criterion (Bardach, 2012). This step is often more difficult than the others since the A&R team must speculate on the future while assuming their understanding of the current situation/problem and alternatives capability are objective and accurate. A firm understanding of previous circumstances, present data, and associated uncertainty are thus necessary to make credible projections and to describe realistic outcomes.

Scenario writing can be a useful approach to describing outcomes. Written in the future perfect tense (articulating outcomes from a perspective in the future looking backward), scenario writing requires creative forward thinking based on current realities and how those realities could change in light of the chosen alternative. Moreover, scenario writing allows for informed speculation on what could go wrong with a given alternative during implementation, lending insight to potential design modifications or adaptive management approaches.

The goal is to develop the best available approximation of what will happen (certainly with respect to each criterion) if a given alternative were implemented. To achieve this, the process should be collaborative and involve stakeholders with different yet complementary views and include all collected evidence and available tools, including models. Models are simplified versions of reality but can build objective intuition and help to achieve more valid and objective projections than purely undisciplined estimation might; however, complete reliance on them may not be sufficient. If the opportunity to use a model presents itself, then it should be paired with the relevant collected evidence. Michel et al. (2005) suggest a variety of evaluative criteria and qualitative outcomes that might reasonably apply to pollution threats of sunken wrecks.

To organize the expected flood of information, Bardach (2012) recommends development of an outcomes matrix. Referred to as a Criteria/Alternatives Matrix by Linquiti (2012), the matrix organizes each alternative in the rows of the matrix and each evaluative criterion across the columns. Each intersecting cell contains a description of the projected outcome, laying the groundwork to clarify tradeoffs.

Step Six: Clarify the Tradeoffs

Step six of the framework allows for selection of alternatives by comparing the tradeoffs associated with each outcome. Bardach (2012) suggests the most common and visible tradeoff is that between cost and the utility or impact of the result and that may hold true for oil threat assessment activities as well. For example, SS MONTEBELLO assessment efforts used federal funds to contract subsea assessment equipment, but only after low cost tools were exhausted (e.g. document research, modeling, expert input). In this case, the funded in-water work appeared the only reasonable alternative for a ship that was in deep water and known to be largely intact. Alternatively, the FERNSTREAM Task Force relied primarily on low cost evidence collection methods that indicated severe structural damage and thus a low likelihood of a pollution threat. Both outcomes are similar (not likely a pollution threat), though the alternatives implemented differed vastly with respect to cost. Neither alternative would fit all shipwreck assessment needs, but each alternative worked best for each Task Force under their unique circumstances.

Traditional tradeoff analysis in the context of the policy analytic process requires scoring each outcome. The scores are numerically weighted by importance, and then compared to see how the cumulative scores for each alternative are ranked. Regional and Area Contingency Plans, contingency planning committees, and other incident-specific guidance may be an objective way to determine relative importance of each outcome.

CONCLUSION:

The NCP's assessment framework for non-emergent oil threats pales in comparison to its framework for evaluating CERCLA threats. Recent assessment experience with the sunken SS MONTEBELLO and M/V FERNSTREAM provide an opportunity to develop a focused problem analysis and decision framework for non-emergent oil threats allowing A&R teams to proactively and methodically evaluate the full nature of a problem as well as the relative efficacy of alternative courses of action available to the FOSC.

The proposed framework is intended to bolster the utility of the NCP's Operational Response Phases for Oil Removal with emphasis on Phase II activities, adding greater context to NRT guidance related to mitigating pollution from legacy wrecks. The SS MONTEBELLO and M/V FERNSTREAM assessment activities serve to benchmark a recent project management paradigm with possible application to RULET targets or other potentially polluting shipwrecks in the U.S. or elsewhere. The combination of promising practices stemming from both efforts paired with an adaptation of a more thorough policy analytic process may provide Regional and Area Committee-level A&R teams with the means to make a concise, compelling, and comprehensive analysis and recommendations to FOSCs for non-emergent oil pollution threats.

TABLE:

Table 1. RULET targets identified in California waters.

Ship	Sank	Location	Estimated oil remaining on-board
M/V Pac Baroness	1987	Western Santa Barbara Channel	7,800 bbls IFO
M/V Puerto Rican	1984	Gulf of the Farallones	8,500 bbls Heavy fuel
SS Jacob Luckenbach	1952	Gulf of the Farallones	8,500 bbls Heavy fuel
M/V Fernstream	1952	San Francisco Bay	12,500 bbls Diesel

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