HSOAC | HOMELAND SECURITY OPERATIONAL ANALYSIS CENTER
AN FFRDC OPERATED BY RAND UNDER CONTRACT WITH DHS

RESEARCH BRIEF

An Integrated Approach to Waterways Safety Risk Assessment for the U.S. Coast Guard

The U.S. Coast Guard (USCG) has a significant role in ensuring the safety, security, stewardship, and efficient functioning of the nation's waterways and marine transportation system. This role includes providing a national network of aids to navigation (e.g., buoys, structures, electronic aids), establishing vessel traffic management practices, restricting access to areas that create safety concerns, and ensuring the safe transport of oil and hazardous materials.

The USCG has developed several risk assessment tools that are designed to address various aspects of waterways safety. However, there has never been a collective review of the tools to understand their effectiveness in addressing the range of safety risks, to identify overlap and gaps, or to assess their ability to account for waterway modernization and evolving challenges.

To address this need, RAND researchers, drawing from established risk management frameworks, developed a tailored Risk Management Framework (RMF), which can help the USCG ensure comprehensive risk management, enhancing operational effectiveness and strategic resilience to support waterways safety and the marine transportation system. Researchers used the framework to assess existing USCG waterways safety risk assessment tools and suggest improvements that would provide a more holistic understanding of safety risks to U.S. waterways.[1]

A Tailored USCG Risk Management Framework

The dynamic nature of U.S. waterways and the marine transportation system demands a robust and adaptable risk management approach. USCG priorities in ensuring the safety of U.S. waterways and the marine transportation system generally fall into three broad categories: critical infrastructure (e.g., bridges, facilities), the environment (e.g., water and air quality, sensitive areas, natural resources), and waterway users and property (e.g., recreational, commercial, military). Traditional maritime risks, such as navigational safety and environmental protection, are compounded by emerging hazards—including reliance on networked electronic information and operational systems, emerging maritime technology, and changing weather patterns—as well as diversity in waterway usage and activities. A risk management framework for the USCG must also be flexible enough to adapt to future uncertainties.

The proposed USCG RMF draws from established risk management frameworks developed by the International Risk Governance Council and the National Institute of Standards and Technology, as well as existing risk management principles used by the USCG, the U.S. Department of Homeland Security, and the U.S. Department of War.[2] The framework addresses systemic risks across multiple dimensions, fostering inclusive risk management,

encouraging dialogue, and integrating scientific knowledge with stakeholder concerns. The primary elements of the RMF are shown in Figure 1 and Table 1.

The first three steps focus on risk understanding and appraisal, and the next three steps focus on risk management and monitoring. The final element, stakeholder engagement, should be integrated into every step in the risk management process.

RAND researchers used the RMF to assess the six major risk assessment tools used by USCG for waterways safety (Table 2). To understand overlaps and gaps in the USCG's existing waterway risk assessment tools, the researchers employed a modified version of the U.S. Government Accountability Office's methodology for evaluating fragmentation, overlap and duplication across governmental activities and programs based on structured interviews with USCG and waterway stakeholders, including tool owners and users, representatives from the commercial shipping industry, and others.

FIGURE 1
Primary Elements of a Tailored USCG Risk Management Framework

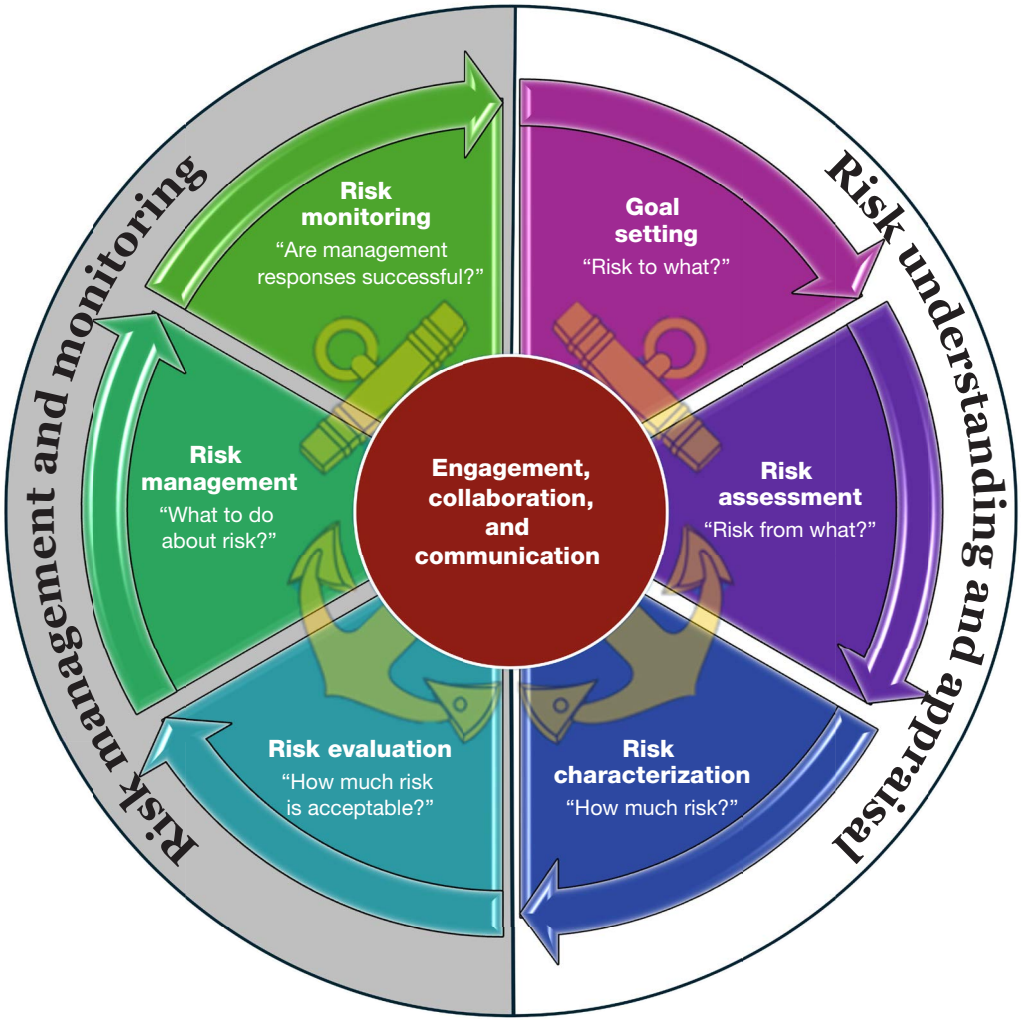


TABLE 1

Primary Elements of a Tailored USCG Risk Management Framework

Step and Question Addressed	Key Features
Goal Setting: Risk to what?	• Understand the operational context. • Set clear, decision-relevant objectives. • Define the scope.
Risk Assessment: Risk from what?	• Understand the sources and potential impacts of risk. • Identify hazards that lead to hazard events, both traditional and emerging, and the processes that generate them.
Risk Characterization: How much risk is there?	• Characterize risk using likelihood and consequence. • Determine overall risk values and priorities. • Include considerations around complexity, uncertainty, and ambiguity.
Risk Evaluation: How much risk is acceptable?	• Evaluate whether identified risks impact stated strategic goals and objectives.
Risk Management: What should be done about the risk?	• Control or mitigate unacceptable risk by developing tailored approaches that account for stakeholder roles and responsibilities.
Risk Monitoring: Are the risk management responses successful?	• Employ continuous monitoring mechanisms to facilitate timely detection and response either when mitigations do not work as intended or when threats emerge.
Stakeholder Engagement: What do stakeholders need to know about risk and how much risk are they willing to tolerate?	• Understand stakeholder objectives, perceptions, expertise, and risk tolerances. • Convey risk information. • Establish buy-in to risk management approaches.

TABLE 2

USCG Waterways Safety Risk Assessment Tools

Tool	Focus
Level of Service Study (LSS)	Defines levels of service required to support mariners' situational awareness and improve waterway efficiency
Navigation Safety Risk Assessment (NSRA)	Evaluates whether a proposed project might introduce risk to mariners, vessels, the environment, or port operations
Port Access Route Study (PARS)	Aims to enhance navigational safety and protect marine environments by managing vessel traffic with other uses of the waterway
Ports and Waterways Safety Assessment (PAWSA)	Aims to ensure and improve navigation safety of a specific waterway while improving coordination and cooperation between the government and the private sector
Waterways Analysis and Management System (WAMS)	Aims to ensure that navigable waterways are marked with appropriate, adequate, and effective aids to navigation
Waterway Suitability Assessment (WSA)	Examines safety and security risks to ports and waterways from proposed liquefied natural gas (LNG) or liquefied hydrocarbon gas (LHG) operations

How Well Do Existing USCG Risk Management Tools Align with the RMF?

Researchers used the RMF to assess the six risk assessment tools, both individually and in relation to each other, to identify how well the tools align with the components of the RMF and support the USCG waterways safety priorities.

Each Tool Gathers Useful Information to Support Different Elements of Waterways Safety

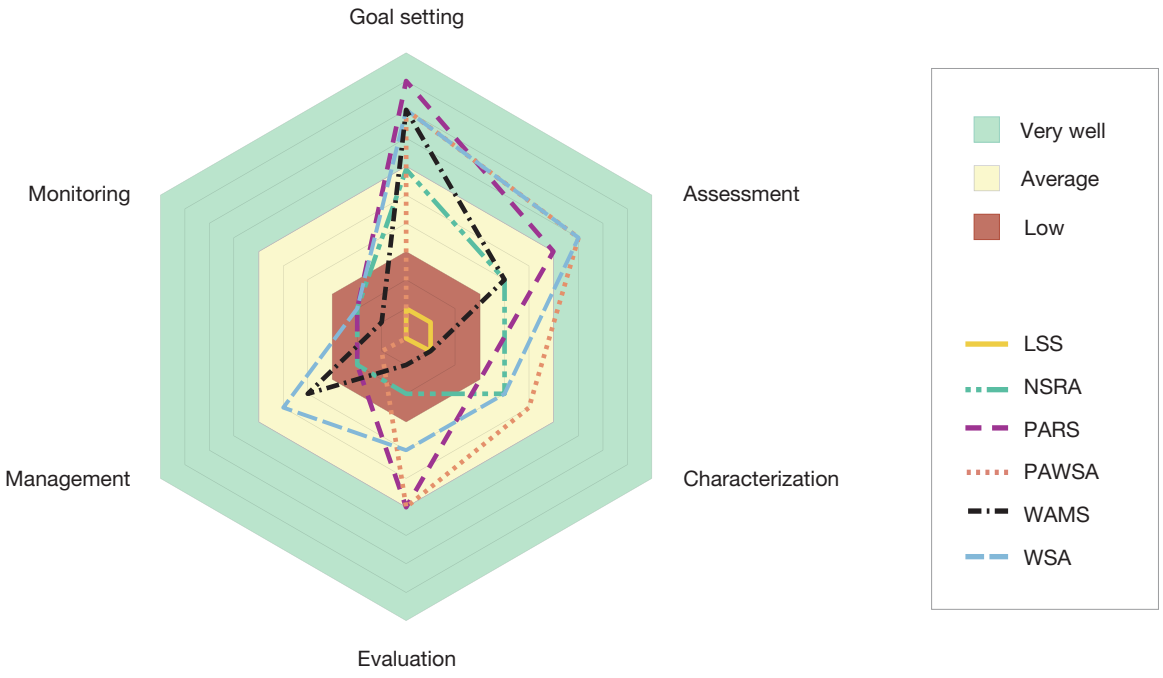
The assessment identified the strengths of existing tools. The PAWSA is the most comprehensive tool for addressing waterway risks, offering users the ability to document risks while also demonstrating the effectiveness of existing safety measures. The WAMS tool has proven effective in guiding USCG leadership decisions regarding the placement or removal of aids to navigation in waterways. The PARS tool is unique in that it enables proactive safety planning and regulatory decisionmaking for large, complex waterways. The three different NSRA processes provide a graduated approach to addressing specific infrastructure within a waterway, while the WSA was clearly laid out to address hazards associated with LNG projects. Although the LSS is not a risk assessment model, LSS analyses support decisions internal to the USCG, providing guidance to design an effective constellation of aids to navigation.

The Tools Tend to Be Used Independently and Do Not Cover All RMF Elements Equally

While each tool serves a distinct purpose, the tools are often utilized independently or in isolation, with minimal attention to future conditions. Furthermore, the tools vary in the extent of their coverage of the elements of the framework, as shown in Figure 2, which displays summary results from the analysis.[3] For example, the PARS scores *very well* on "Goal Setting," *average* on "Risk Assessment" and "Risk Evaluation," and *low* on the remaining steps. Tools tend to be stronger in addressing hazards and priorities and weaker in characterizing, evaluating, and managing risk. For example, the NSRA has three levels of assessment, which are correlated with increasing levels of risk, but the NSRA documentation does not provide guidance on how to determine risk acceptability and delegates risk management to the permitting agency, without a formal process

FIGURE 2

Tool Coverage of Risk Management Framework Principles



While all the waterways safety tools provide value, they are not currently used in a coordinated way that would provide a holistic vision of risk.

for follow-up. None of the tools adequately covers risk monitoring, which suggests that important feedback mechanisms for identifying and managing risk are lacking in all the tools.

Tools Often Overlap or Duplicate Functions, While Use of Differing Methodologies Can Create a Fragmented Understanding Of Risk

Researchers identified several examples of overlap and duplication in the tools. All or most of the tools consider some of the same risk drivers, such as surface vessel and traffic volume risks, geography, weather, and critical infrastructure. At the same time, several drivers, including cyber risks and human vulnerabilities, have minimal to no coverage. In addition, the tools routinely enlist stakeholder input from the same pool of candidates. This overlap is useful in that some waterways have consistent input from experts familiar with local operations, but there is also a high potential for reinforcing blind spots or gaps in understanding the hazards, priorities, and stakeholder values for a given waterway.

In addition, because each of the tools serves a different purpose, this can create fragmentation when each focuses on different geographic areas, risk reduction strategies, processes, methodologies, or timelines. The differences in these risk assessment approaches lead to a fragmented understanding of risk levels and limit information sharing across tools.

Recommendation: Redesign the USCG Waterways Safety Risk Assessment Process to Better Leverage the Information and Outputs Generated by Each Tool

While all the waterways safety tools provide value, they are not currently used in a coordinated way that would provide a holistic vision of risk. The researchers' recommendations are thus designed to better align the suite of USCG waterway risk assessment tools with the RMF, to address the implications of fragmentation and overlap, and to provide a more holistic understanding of safety risks to a given waterway. The main focus of these recommendations is to redesign the USCG waterways safety risk assessment process in a systematic and coordinated way that improves the efficiency, coordination, and integration of existing tools. Figure 3 illustrates how an enterprise approach could be carried out over a multiyear period for both critical and noncritical waterways. The arrows show the proposed sequencing, periodicity, and information flows across tools for critical and other waterways. The USCG can support this redesign by implementing a set of related process improvements briefly described below.

Establish a Standard to Designate Critical Waterways

The standard could be based on impacts to national strategic interests in the event that the waterway is no longer usable. As illustrated in Figure 3, under this approach, critical waterways would receive more frequent risk assessments (nominally every five years) than other waterways (nominally every ten years), unless there was a dramatic change to the activities in the waterway.

Designate a Phased Approach to Conducting a PAWSA

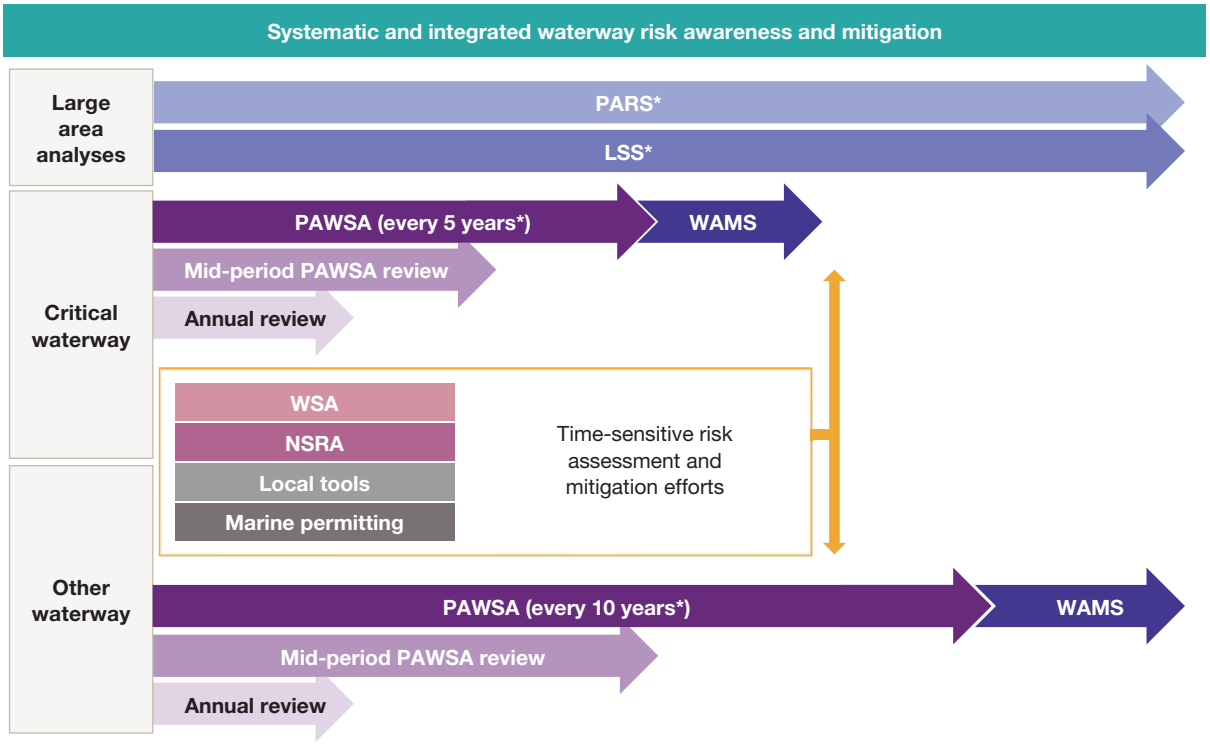
As the most comprehensive tool for addressing waterway risks, the PAWSA would involve both an annual review and a mid-period review (designated by horizontal arrows in Figure 3). The short annual review would determine whether the "Set Goals" and "Risk Assessment" steps remain valid. The mid-period review would include those steps while also analyzing and validating the decisions made during the "Risk Characterization" and "Risk Evaluation" steps.

Incorporate Any New WSAs, NSRAs, and Local Tools into the Annual PAWSA Review

This process (designated by the gold box and vertical arrows in Figure 3) could determine whether the cumulative effects of new structures or activities impacted the waterway to an extent that exceeded the risk tolerance or severity level that would necessitate a new PAWSA. The USCG should also include developing a common risk index number calculation method across the WSA, the NSRA, and other tools to provide an opportunity for transferability and integration of risk characterization across tools.

FIGURE 3

Potential Future Employment of Waterways Safety Risk Tools



*Also conducted when significant waterway change is anticipated.

Conduct a WAMS Following a PAWSA

This sequence would take advantage of the information generated, and decisions made by, stakeholders and reduce repetitive information collection on potential hazards and areas of increased risk.

Create a Consolidated, Accessible Database for Risk Assessments

Data, reports, and decisions made during WSAs and NSRAs should be cataloged and made available for use in future PAWSAs as baseline material. The same database could also capture data and analysis of the number, type, and potential risks associated with assessments conducted during marine permitting or other local tools.

An Integrated Approach to Waterways Safety Risk Assessment

Implementation of this integrated approach, as well as options to address specific challenges for each of the risk assessment tools (described in the full report) can potentially reduce the burden on stakeholders while ensuring that risks are comprehensively and consistently identified and managed.

Notes

[1] A more detailed discussion of the analysis can be found in Eric Cooper, Susan A. Resetar, Rahim Ali, Jeff Anderson, Karishma R. Mehta, Millard McElwee, Rachel Steratore, Sarah Weilant, Michelle D. Ziegler, Adaeze Ibeanu, Isabelle Winston, Kristin J. Leuschner, and Jacob Kaufhold, *A Review of Coast Guard Waterways Safety Risk Assessment Tools*, RAND Corporation, RR-A3612-1, 2026.

[2] The Department of War is designated the Department of Defense under Public Law 81-216, National Security Act Amendments of 1949.

[3] Because stakeholder engagement and communication are a fundamental aspect of all the USCG tools, this element was not explicitly included in the figure and is considered as an integral aspect of each element.

This research brief describes work done in the Homeland Security Operational Analysis Center and documented in *A Review of Coast Guard Waterways Safety Risk Assessment Tools*, by Eric Cooper, Susan A. Resetar, Rahim Ali, Jeff Anderson, Karishma R. Mehta, Millard McElwee, Rachel Steratore, Sarah Weilant, Michelle D. Ziegler, Adaeze Ibeanu, Isabelle Winston, Kristin J. Leuschner, and Jacob Kaufhold, RR-A3612-1, 2026 (available at www.rand.org/t/RRA3612-1). To view this brief online, visit www.rand.org/t/RBA3612-1.

This brief was published in 2026.

RB-A3612-1