Identifying local oil spill risk factors:

An application of Hazard Identification within the International Maritime Organization Formal Safety Assessment framework in Washington State

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Oil spills from commercial vessels are low probability, high consequence events that threaten economic, ecological, cultural, and natural resources. Washington State Department of Ecology Spill's Program (Ecology) has a robust risk assessment program that focuses on identifying and reducing oil spill risks to Washington waters. In 2017-2018, Ecology developed and implemented a novel application of the International Maritime Organization (IMO) Formal Safety Assessment process to lead a collaborative Hazard Identification for oil spill risk in Grays Harbor, Washington. This use of the IMO Formal Safety Assessment Process to assess oil spill risk was a first for Washington State and appears to be unique among US state governments.

Working with area tribes, government agencies, and stakeholders, Ecology modified the IMO Formal Safety Assessment process to focus on local factors that could contribute to oil spill risks. Ecology facilitated structured brainstorming discussions during two workshops to complete Hazard Identification. Focusing on local factors fostered collaborative discussion among workshop participants, and allowed the process to benefit from local expertise about the characteristics of waterway and operational practices. The workshops resulted in the identification of 43 local factors related to oil spill risks, 34 recommendations to reduce risks based on current vessel traffic, and 10 recommendations to consider if vessel traffic increases in the future. The recommendations from this assessment are directly informing operations in Grays Harbor; in 2019, the Grays Harbor Safety Committee voted to adopt the risk assessment final report as an addendum to their Harbor Safety Plan. Ecology is also working with area tribes, government agencies, and stakeholders to review and prioritize the risk assessment recommendations with a goal of developing implementation plans for selected measures.

This application of the IMO Formal Safety Assessment process represents a repeatable, scalable, and defensible method for conducting oil spill risk assessments. Ecology plans to use this process in other state waterways, and invites other organizations to consider adopting these methods. The presentation will walk through how to apply this process for localized waterway risk assessments and discuss best practices for success. Additionally, Ecology will discuss new risk analysis initiatives directed by the Washington State Legislature, including development of a quantitative model for evaluating oil spill risk and the potential effect of risk reduction measures.

INTRODUCTION

Ecology Risk Assessments

The Washington State Department of Ecology (Ecology) Spills Program conducts oil spill risk assessments as directed and funded by the Washington State Legislature. Our assessments provide the Governor, the Legislature, tribes, stakeholders, and the public with timely and relevant information about current and potential future oil spill risks and recommended measures that could reduce risks. Past assessments include qualitative studies of oil transportation risks (Ecology, 2015), and quantitative analyses of vessel spill risks for the Puget Sound and the Columbia River (Van Dorp & Merrick, 2017, Ecology 2017). In 2017-19, Ecology received funding to facilitate a risk assessment for oil spills from commercial vessels in Grays Harbor (Ecology, 2016). The Grays Harbor Vessel Traffic Risk Assessment (VTRA) is unique because it was structured using the International Maritime Organization (IMO) Formal Safety Assessment (FSA) process and resulted in the identification of local risk factors, existing safeguards, and recommendations for consideration by tribes and stakeholders. The final report of the Grays Harbor Vessel Traffic Risk Assessment (VTRA) describes the risk assessment process and provides our findings and recommendations (Ecology, 2018a).

Grays Harbor overview

Grays Harbor is a large inlet on the central coast of Washington (Figure 1). The bay comprising Grays Harbor extends east for approximately 15 miles to the mouth of the Chehalis River (National Oceanic and Atmospheric Administration [NOAA], 2017a).

The Port of Grays Harbor operates four marine terminals in the vicinity of the cities of Hoquiam and Aberdeen (Port of Grays Harbor, 2018). Approximately 100 deep draft commercial

vessels per year call on Grays Harbor (Ecology, 2018b). Two projects were identified with active permit applications that could potentially increase vessel traffic (BergerABM, 2017; City of Hoquiam, 2018).

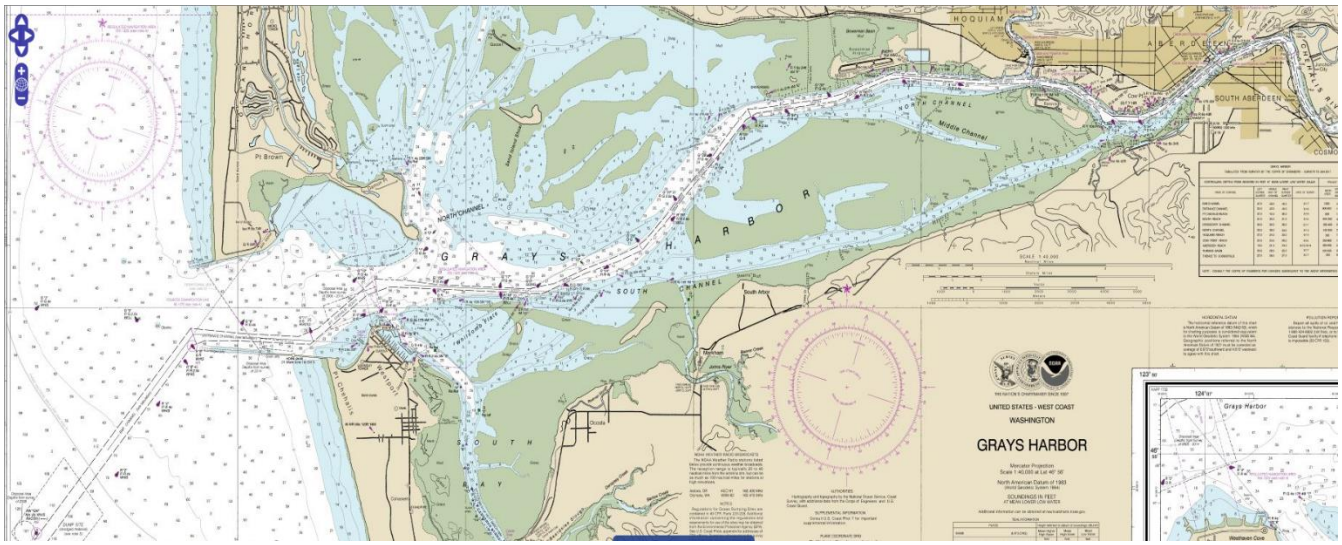


Figure 1: Excerpt of Navigational Chart 18502, Grays Harbor, Washington (NOAA, 2017b)

The Port also manages the Grays Harbor Pilots and operates Westport Marina, which serves commercial fishing, tribal fishing, and recreational boats (Port of Grays Harbor, 2018). Commercial fishery landings in Westport in 2016 were the highest on the West Coast (excluding Alaska) with 108 million pounds, valued at $59 million (NOAA, 2017c).

A study for the Port of Grays Harbor found maritime activity at the Port generated 574 direct jobs and $143 million in business revenue in 2013. During the same year, commercial fishing in Westport generated 1,067 direct jobs and $204 million in business revenue (Martin Associates, 2014).

The Quinault Indian Nation has treaty rights to fishing at all usual and accustomed ground (Washington Governor's Office of Indian Affairs, 2020).

There is an active Harbor Safety Committee that meets every two months. The Grays Harbor Safety Committee publishes a Harbor Safety Plan with Standards of Care, which are designed as a reference guide for safe and environmentally sound vessel movements and operations in and around the port area (Grays Harbor Safety Committee, 2014).

Anchorages in Grays Harbor are limited and are managed by the Grays Harbor Pilots. Anchorages in Grays Harbor are not formally designated or managed by the U.S. Coast Guard (Grays Harbor Safety Committee, 2014).

Vessel traffic is managed in cooperation between the Port of Grays Harbor, Grays Harbor Pilots, vessel agents, and the terminal tenants that ships call on (Grays Harbor Safety Committee, 2014). This cooperative system includes the use of an online vessel arrival tool and database that is updated by users of the system.

Risk Assessment Approach

The unique characteristics of Grays Harbor led Ecology to consider new approaches to conducting this assessment. With approximately 100 deep-draft vessel calls per year, vessel traffic density is lower in Grays Harbor than in other state waters (e.g., Puget Sound, Columbia River). The long, narrow channel extending from the mouth of Grays Harbor to the marine terminals results in linear traffic flows, with the only crossing traffic coming from Westport Marina, near the mouth of the harbor. The active Harbor Safety Committee with strong local representation provided a focal point for Ecology's engagement, and a starting point for creating a workgroup to help plan the risk assessment.

While the relatively low traffic volume and absence of crossing traffic could decrease oil spill risks, several local factors make Grays Harbor a challenging port to navigate. There are

limited anchorage areas, a hazardous bar to cross, frequent storms in the winter, and fog in the summer and fall (NOAA 2017a). The combination of lower- and higher-risk attributes motivated Ecology to look for a flexible approach to risk analysis. Desired features of the analytical approach included:

- Collaborative: able to fully incorporate the knowledge and expertise of local waterway users, including industry, government agencies, tribes, and non-governmental organizations
- Flexible: could accommodate an initial qualitative assessment, and follow-on quantitative analysis if required
- Credible: based on recognized risk assessment methods and practices
- Defensible: sufficient structure and process that the results are logical, can be explained, and would withstand critical scrutiny
- Repeatable/Scalable: Could be used to conduct future risk assessments in other state waterways
- Cost efficient: able to be conducted by Ecology staff, with little to no need for contract support

Ecology reviewed a variety of risk assessment processes, and determined that the International Maritime Organization Formal Safety Assessment process could be adapted to meet our specific needs.

Goals of the risk assessment

The goals of the Grays Harbor Vessel Traffic Risk Assessment (VTRA) were to:

- Assess baseline and changing oil spill risks from commercial vessels in Grays Harbor.

- Identify measures that could help reduce the risks of oil spills.
- Assess oil spill response preparedness.
- Identify baseline response capability.

METHODS

Formal Safety Assessment

Ecology modified the International Maritime Organization (IMO) Formal Safety Assessment (FSA) process to conduct the Grays Harbor VTRA. Adopted by the IMO in 2002, Formal Safety Assessments use a structured and systematic methodology to assess the risks relating to maritime safety and the protection of the marine environment, and for evaluating the costs and benefits of options for reducing these risks (IMO, 2002). The FSA process includes the following steps:

- Preparatory Step: Definition of Goals, Systems, Operations
- Step 1: Hazard Identification
- Step 2: Risk Analysis
- Step 3: Risk Control Options
- Step 4: Cost Benefit Assessment
- Step 5: Recommendations for Decision Making

Initial Focus

Ecology focused on completing the Preparatory Step and Step 1, Hazard Identification, during Fiscal Year 2018 (July 1, 2017 – June 30, 2018). Ecology's Spills Program staff facilitated two workshops to conduct the Hazard Identification. Ecology added a decision point

to the Formal Safety Assessment process after Hazard Identification to determine whether there was a need to continue with Steps 2-5.

To meet the oil spill response preparedness goals, Ecology led a separate collaborative process to better understand response capacity for the area if all available resources were deployed for a major oil spill response. In 2019, Ecology published the Grays Harbor Response Capacity Analysis (Ecology, 2019).

Hazard Identification Process

Hazard Identification is the first step in the Formal Safety Assessment process. The purpose is to identify a list of hazards and associated scenarios, prioritized through the use of screening criteria, which are specific to the problem under review (IMO, 2002). Hazard Identification can be accomplished through a variety of techniques, such as structured group brainstorming or Fault Tree Analysis (American Bureau of Shipping, [ABS], 2000). Ecology facilitated structured brainstorming discussions during two workshops to complete the Hazard Identification process.

During the first Hazard Identification workshop, participants reviewed potential incidents that could result in oil spills from commercial vessels, with a goal of identifying any local factors that could contribute to these incidents. A list of local factors was the primary outcome of the first workshop.

In the second Hazard Identification workshop, participants reviewed each local factor listed in the first workshop, identified safeguards currently in place to prevent incidents, and discussed potential high-level recommendations that could improve oil spill prevention.

The Hazard Identification process centered on the discussion of local factors and high-level recommendations rather than other risk components, such as the relative frequency of vessel incidents or the consequence of oil spills, for two reasons.

First, commercial vessel incidents, like collisions or groundings resulting in an oil spill, are relatively rare events both globally and in the historical data available for Grays Harbor. Ecology data for 2007–2017 show only one oil spill from a large commercial vessel: a 1-gallon hydraulic oil spill from a cargo ship in 2011 (Ecology, 2018c). The last major oil spill in the vicinity of Grays Harbor was the oil barge *Nestucca* in December 1988 (NOAA, 2017d). Rather than ask participants to provide qualitative judgments about the likelihood of these relatively rare events, the workshops sought to benefit from local knowledge and expertise about the characteristics of the commercially navigable waterway and operational practices.

Additionally, the overall Grays Harbor Vessel Traffic Risk Assessment and the Hazard Identification workshops were intended to improve oil spill prevention and preparedness. It was beyond the scope of this assessment to model potential spill consequences in terms of the fate, transport, and effect of spilled oil.

A distinguishing feature of the Hazard Identification process was the use of structured brainstorming to determine local factors, existing safeguards, and high-level recommendations. To preserve the collaborative nature of the workshops, Hazard Identification did not include ranking or voting to prioritize or eliminate inputs provided by participants. The local factors, existing safeguards, and high-level recommendations that resulted from this process comprised an inclusive listing for consideration by tribes and stakeholders.

Planning

Ecology engaged a workgroup of representatives from governments and organizations to help guide planning for the Hazard Identification. The workgroup met four times between September 2017 and February 2018. Workgroup meetings included discussions of the scope for the Hazard Identification, dates and locations for the workshops, potential workshop invitees, reviews of draft Hazard Identification workshop material and tools, and updates from Ecology on workshop planning and outreach to the public regarding the Grays Harbor Vessel Traffic Risk Assessment. Ecology considers the use of a workgroup to plan the risk assessment a best practice, and recommends organizations initiating a similar effort consider incorporating a planning group with representatives from government agencies, tribes, and stakeholders.

Hazard Identification Workshop 1

Overview

Hazard Identification Workshop 1 was held on January 25, 2018 at the Port of Grays Harbor. Participants included representatives from 15 government agencies, tribes, local industry, and non-profits. Participants were provided a workshop handbook before the workshop (Ecology, 2018d). During Hazard Identification Workshop 1, Ecology facilitated structured brainstorming discussions to review vessel incidents that could result in an oil spill (e.g., collisions, allisions, groundings, fires/explosions, structural failure). The goal of these discussions was to identify any local factors that could contribute to vessel incidents. Examples of local factors included features like the submerged south jetty at the entrance to Grays Harbor, which could contribute to vessel grounding risks, and several sharp turns in the deep draft channel, which could contribute to collision, allision, and grounding risks.

Workshop tools

To promote a systematic consideration of potential local factors, Ecology defined four waterway areas, as shown in Figure 2.

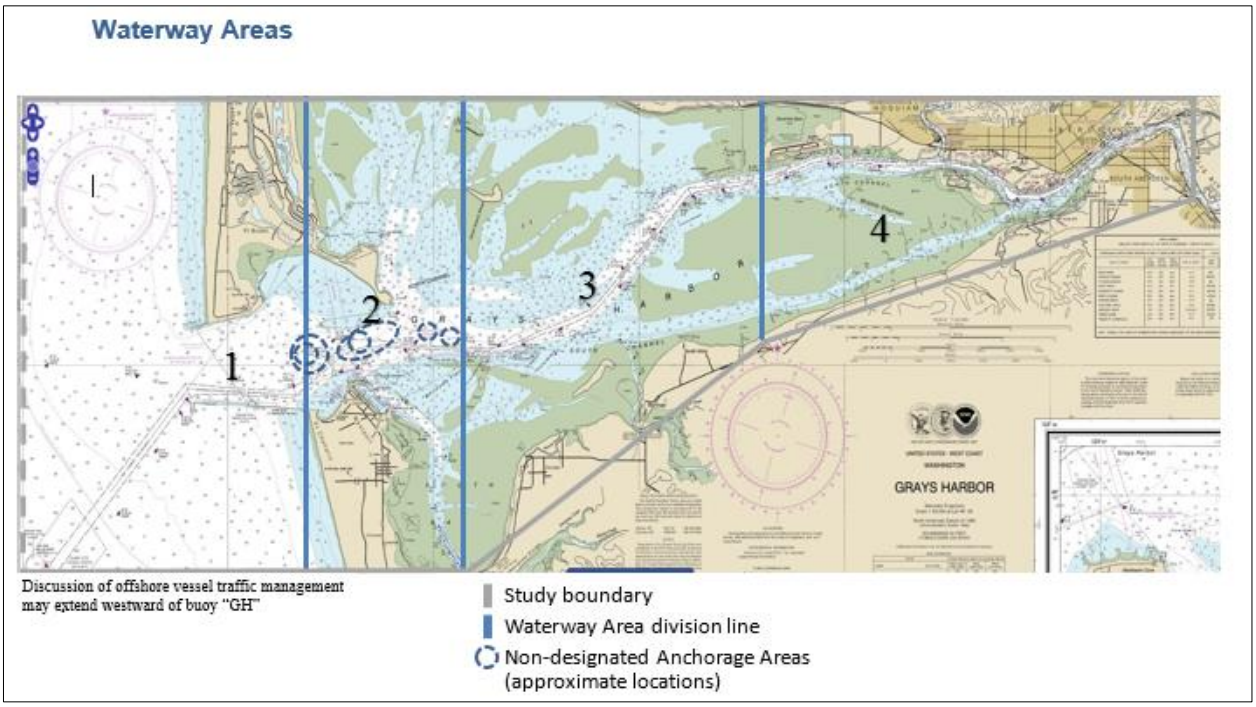
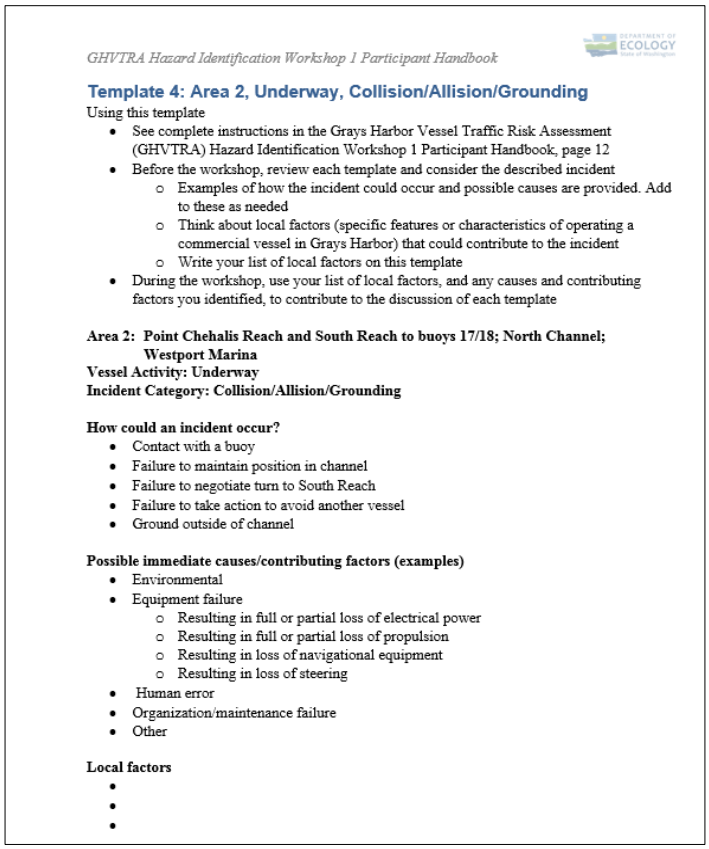


Figure 2: Waterway areas defined for Grays Harbor VTRA Hazard Identification workshops (Ecology, 2018a)

Hazard identification templates were provided to workshop participants to guide discussions. The templates were organized by waterway area, vessel activity, and incident type. Potential immediate and contributing causes were adapted from the Pacific States/British Columbia Oil Spill Task Force Data Dictionary (Pacific States/British Columbia Oil Spill Task Force, 2018). An example blank template is shown in Figure 3. The full set of templates were included in the participant handbook (Ecology, 2018d). During the workshop, Ecology reviewed each template and encouraged all participants to contribute to the discussion of local factors.



GHVTRA Hazard Identification Workshop 1 Participant Handbook

Template 4: Area 2, Underway, Collision/Allision/Grounding

Using this template

- See complete instructions in the Grays Harbor Vessel Traffic Risk Assessment (GHVTRA) Hazard Identification Workshop 1 Participant Handbook, page 12
- Before the workshop, review each template and consider the described incident
  - Examples of how the incident could occur and possible causes are provided. Add to these as needed
  - Think about local factors (specific features or characteristics of operating a commercial vessel in Grays Harbor) that could contribute to the incident
  - Write your list of local factors on this template
- During the workshop, use your list of local factors, and any causes and contributing factors you identified, to contribute to the discussion of each template

Area 2: Point Chehalis Reach and South Reach to buoys 17/18; North Channel; Westport Marina
Vessel Activity: Underway
Incident Category: Collision/Allision/Grounding

How could an incident occur?

- Contact with a buoy
- Failure to maintain position in channel
- Failure to negotiate turn to South Reach
- Failure to take action to avoid another vessel
- Ground outside of channel

Possible immediate causes/contributing factors (examples)

- Environmental
- Equipment failure
  - Resulting in full or partial loss of electrical power
  - Resulting in full or partial loss of propulsion
  - Resulting in loss of navigational equipment
  - Resulting in loss of steering
- Human error
- Organization/maintenance failure
- Other

Local factors

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-
-

Figure 3: Example template used during Hazard Identification Workshop 1. (Ecology, 2018a)

Results: Local factors

Ecology recorded local factors identified by participants during Hazard Identification Workshop 1, and sent the draft list of local factors to participants for review and comment following the workshop. The draft list and the completed templates from Workshop 1 were included in the participant handbook for Hazard Identification Workshop 2 (Ecology, 2018e).

Following Workshop 2, Ecology removed several local factors and revised the wording of others based on participant comments received before, during, and after the workshop. The resulting list comprised 43 local factors that could influence oil spill risks. The complete list of local factors is included in the Grays Harbor VTRA Final Report (Ecology, 2018a).

The list of local factors does not quantify the likelihood of incidents, accidents, or oil spills related to these features of the commercially navigable waterway of Grays Harbor. Rather, the list of local factors was developed through structured brainstorming as an interim step in a qualitative, collaborative process. The local factors identified by participants in Hazard Identification Workshop 1 facilitated a discussion of existing safeguards and high-level recommendations during Hazard Identification Workshop 2.

Hazard Identification Workshop 2

Overview

Hazard Identification Workshop 2 was held on February 28, 2018 at the Port of Grays Harbor. Participants included representatives from 11 government agencies, tribes, local industry, and non-profit organizations. Participants were provided a workshop handbook before the workshop (Ecology, 2018e). During Hazard Identification Workshop 2, Ecology reviewed the local factors identified during Workshop 1, and facilitated structured brainstorming discussions to determine existing safeguards and high level recommendations.

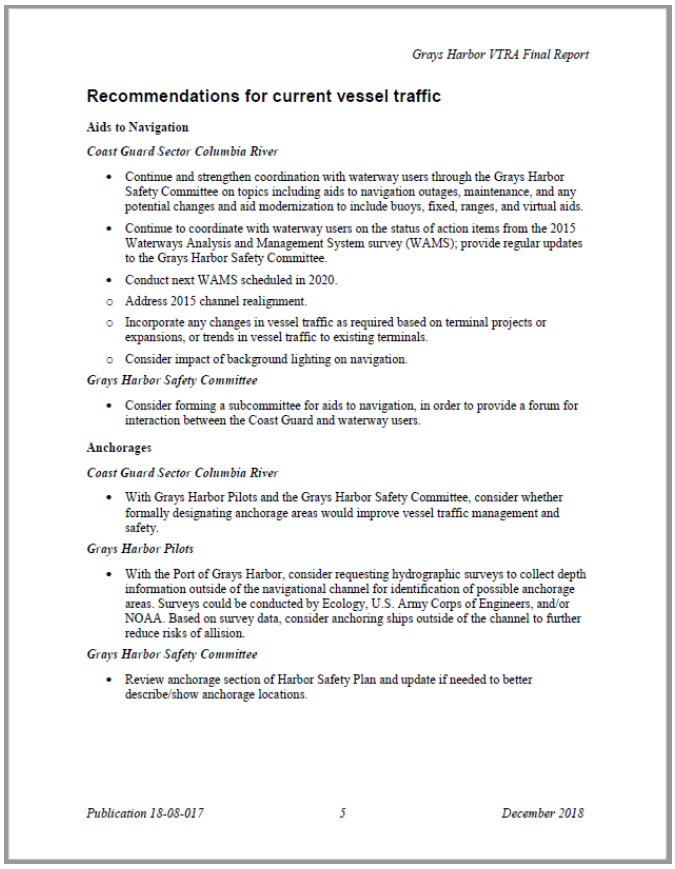
Results: Existing safeguards and high-level recommendations

Existing safeguards are measures intended to prevent hazards from causing vessel incidents or accidents, which could result in an oil spill. Discussions during the workshop focused on existing safeguards that are implemented at the local or regional level. These local measures supplement maritime safety programs that are administered by international organizations, federal and state government agencies, and industry (Ecology, 2017; Frittelli, Andrews, Parfomak, Pirog, Ramseur, & Ratner, 2017).

Thirty four high-level recommendations were developed for current vessel traffic levels and ten for potential future increases in vessel traffic. The complete list of recommendations is

available in the Grays Harbor VTRA Final Report (Ecology, 2018a). Recommendations were broadly organized into nine categories: Aids to Navigation, Anchorages, Bar and Approaches, Current, Fire/Explosion, Fishing Vessels and Fishing Gear, Harbor Safety Plan, Offshore Traffic, and Surveys.

Under each topic, recommendations were organized by the entity who could take action. A sample of recommendations are shown in Figure 3.



Grays Harbor VTRA Final Report

Recommendations for current vessel traffic

Aids to Navigation

Coast Guard Sector Columbia River

- Continue and strengthen coordination with waterway users through the Grays Harbor Safety Committee on topics including aids to navigation outages, maintenance, and any potential changes and aid modernization to include buoys, fixed, ranges, and virtual aids.
- Continue to coordinate with waterway users on the status of action items from the 2015 Waterways Analysis and Management System survey (WAMS); provide regular updates to the Grays Harbor Safety Committee.
- Conduct next WAMS scheduled in 2020.
  - Address 2015 channel realignment.
  - Incorporate any changes in vessel traffic as required based on terminal projects or expansions, or trends in vessel traffic to existing terminals.
  - Consider impact of background lighting on navigation.

Grays Harbor Safety Committee

- Consider forming a subcommittee for aids to navigation, in order to provide a forum for interaction between the Coast Guard and waterway users.

Anchorages

Coast Guard Sector Columbia River

- With Grays Harbor Pilots and the Grays Harbor Safety Committee, consider whether formally designating anchorage areas would improve vessel traffic management and safety.

Grays Harbor Pilots

- With the Port of Grays Harbor, consider requesting hydrographic surveys to collect depth information outside of the navigational channel for identification of possible anchorage areas. Surveys could be conducted by Ecology, U.S. Army Corps of Engineers, and/or NOAA. Based on survey data, consider anchoring ships outside of the channel to further reduce risks of allision.

Grays Harbor Safety Committee

- Review anchorage section of Harbor Safety Plan and update if needed to better describe/show anchorage locations.

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Figure 4: Excerpt of recommendations from the Grays Harbor Vessel Traffic Risk Assessment Final Report. (Ecology, 2018a)

Potential increases in traffic were discussed in qualitative terms, to consider what changes to safeguards and recommendations might be prudent if vessel traffic is higher in the future than it is today. At the time the Grays Harbor VTRA was conducted, there were two projects with active

permit applications that could potentially increase vessel traffic (BergerABM, 2017; City of Hoquiam, 2018). This qualitative discussion was not intended to determine risks that could potentially be associated with the two projects, and it does not take the place of any environmental reviews or analysis of specific proposals. The Grays Harbor VTRA does not address potential impacts of increased vessel traffic to Quinault Indian Nation access to treaty resources, including usual and accustomed fishing areas.

To preserve the collaborative nature of the workshops, Hazard Identification did not include ranking or voting to prioritize or eliminate inputs provided by participants. Local factors, existing safeguards, and high-level recommendations that resulted from this process should be considered an inclusive listing for consideration by tribes and stakeholders.

Formal Safety Assessment process decision

Following the Hazard Identification Workshops, Ecology considered the costs and benefits of continuing with the remaining steps of the Formal Safety Assessment process. Ecology estimated analysis and reporting to complete the process could cost between $150,000 and $600,000. Ecology concluded that continuing the Formal Safety Assessment would be unlikely to produce substantive recommendations beyond those already identified. Ecology ended the Formal Safety Assessment Process at the completion of Step 1, Hazard Identification, due to the significant resources (analysis costs, staff time, participant time) required for the remaining steps and the uncertain benefit that would result.

The local factors, existing safeguards, and high-level recommendations developed in the Hazard Identification workshops provide a resource for tribes and stakeholders to consider in continuing to improve oil spill prevention and preparedness. Current vessel traffic levels and a

review of global, national, and local vessel incident and spill data suggest the risk of an oil spill from a covered vessel (i.e., a tank vessel, or a cargo vessel or passenger vessel greater than 300 gross tons) in Grays Harbor can be characterized as low-probability and high-consequence, as quantitative risk studies have found for other waterways.

A consequence of not completing the Formal Safety Assessment process is that Ecology cannot provide information about the amount of risk that could be reduced by implementing the high-level recommendations, or the costs of implementation. These will have to be discussed qualitatively.

ACTIVITIES FOLLOWING THE REPORT PUBLICATION

On April 16, 2019, the Grays Harbor Safety Committee voted to adopt Ecology's final report as an addendum to the Grays Harbor Safety Plan, to ensure the recommendations were available for consideration. In the summer of 2019, the Grays Harbor Safety Committee committed to forming a subcommittee to develop a port-wide marine firefighting plan, one of the recommendations from the report. The Committee also voted to keep meeting on a bimonthly basis rather than moving meetings to quarterly, as had been planned, until they completed a review of the report recommendations for potential implementation.

CONCLUSION

The process developed by Ecology for the Grays Harbor Vessel Traffic Risk Assessment presented several advantages compared to risk analyses led by Ecology in the past. The Grays Harbor VTRA followed the International Maritime Organization Formal Safety Process. This gave credibility to the process and provided an existing set of tools and guidance for Ecology to draw

from. Using the Formal Safety Assessment process also allowed flexibility. Ecology could weigh the likely costs and benefits of completing the quantitative steps of the FSA process. In this case, Ecology concluded participants received the most benefit from the qualitative elements of the FSA.

The focus on local factors and high-level recommendations allowed a wide variety of participants to engage in the workshops in a meaningful way, ensuring the process benefitted from their experience in the local waterways. The tools developed by Ecology for the Hazard Identification workshops were easy to use, and enabled meaningful conversations about the unique factors of Grays Harbor.

By not prioritizing recommendations during the assessment process, Ecology was able to preserve collaboration throughout the workshops. This permitted the Grays Harbor Safety Committee to consider the report recommendations in the way that best meets their needs. Ecology realized a significant cost savings by developing a process that could be completed entirely with staff resources. While this qualitative approach will not work in every situation, it provided Ecology with a viable way to advance oil spill prevention in one Washington community.

Ecology recommends Harbor Safety Committees, other industry groups, government agencies, and tribes consider adapting the Formal Safety Assessment for their own needs. In our experience, it met all of our requirements and enhanced our collaboration with the tribes and stakeholders who have interests in oil spill prevention in Grays Harbor.

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