Vessel Movement Module – Updates and Follow Up

Modeling Team

JD Ross Leahy (Presenter), Adam Byrd, Alex Suchar

DEPARTMENT OF ECOLOGY
State of Washington

Today's agenda

1. **Background**
2. **Review of Technical Discussions**
3. **VMM Progress Update**
4. **Next Steps**
5. **Questions and Comments**

Today's discussion topics

- Feedback or comments on recent technical discussion sessions
- Current status of our work on the vessel movement module
- Ways to improve upcoming webinars and discussions

5

Legislative background

- ESHB 1578 was passed in 2019 to reduce the risk of oil spills, and protect Southern Resident Killer Whales
- Ecology's Spills Program tasked to undertake or assist with multiple policy initiatives in the bill, including the development of an oil spill risk model

6

Our project team

- Adam Byrd, PhD
  Database administration, Geographic Information Systems
- Alex Suchar, PhD
  Statistical and mathematical modeling
- JD Ross Leahy, Licensed Master
  Maritime operations

7

Research philosophy

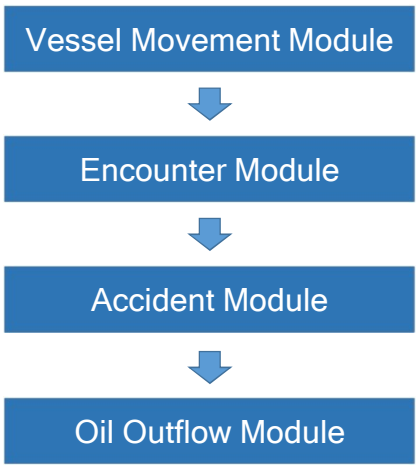
Transparent	• Open • Inclusive
Reproducible	• Well documented • Methodologically sound
Credible	• Peer reviewed • Validated

8

Model development project goals

- Produce **a tool** to quantitatively assess current and potential oil spills risks from covered vessels in Washington waters
- Provide **a framework** for future oil spill risk analyses

Modeling Approach



Vessels move in the system according to their empirical distribution

Measures and evaluates relationship of each vessel to the shore and other vessels

Evaluates situations for their potential to lead to accidents

Estimates the size of oil spills that result from accidents

Vessel Movement Module

Purpose:

- Simulate vessel activity and potential changes in traffic volume with AIS driven model

Vessel Movement Module Review

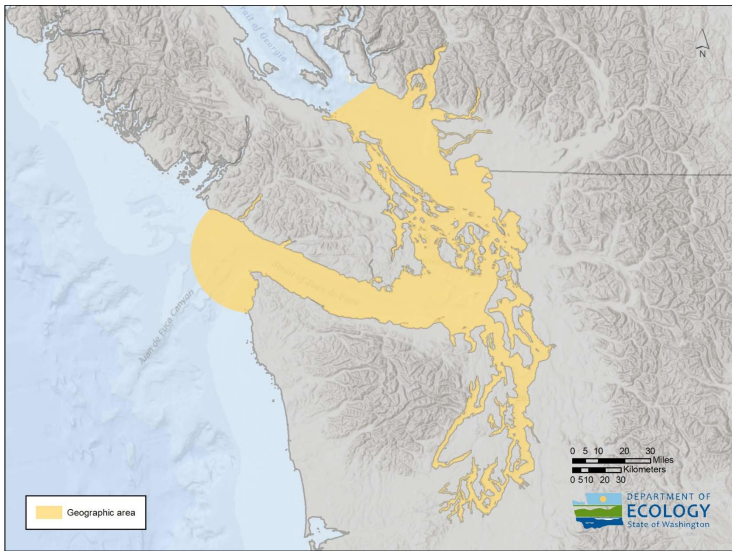
Identify vessel tracks

Collect tracks into routes

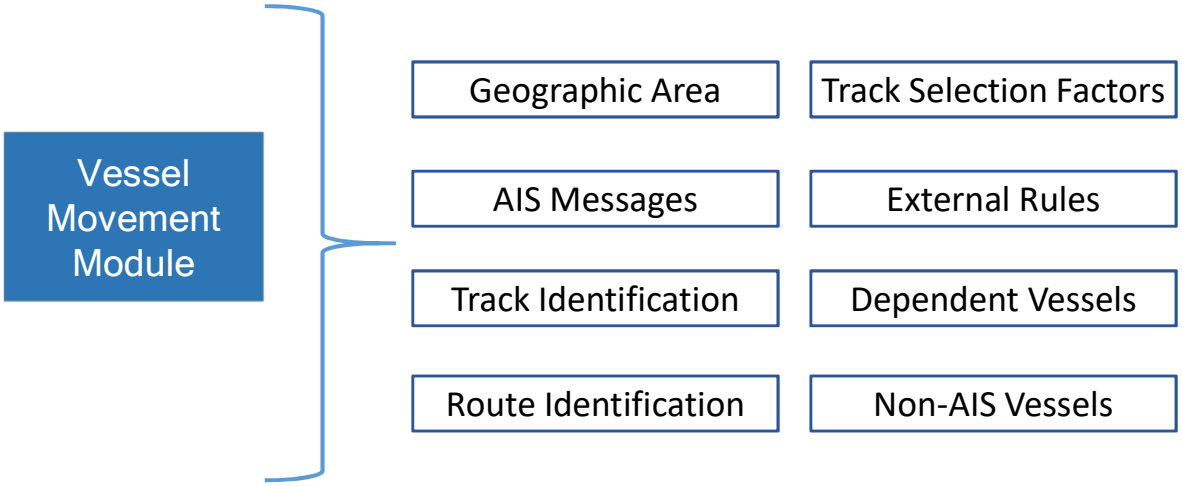
Statistical analysis of factors that could affect vessel distribution on tracks

Simulate vessels on tracks based on distribution

Simulate additional rules and non route based vessels



Vessel Movement Module: Components



13

Technical discussions on module components

- Technical Input and Discussion Sessions
  - October 21, 2020 – Track Selection Factors
  - October 27, 2020 – External Rules
  - October 29, 2020 – Dependent Vessels
  - November 4, 2020 – Non AIS Vessels

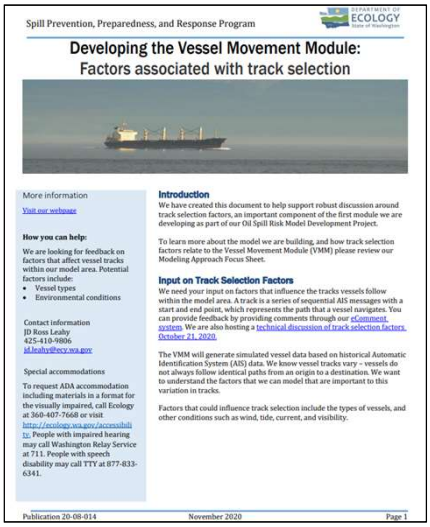
- Module Component Summaries
  - Written description of selected components

14

Track Selection Factors: Vessel Type

Need to classify vessels by type:

- Vessel type information provided by AIS is not specific enough to meet our needs
- For instance, vessels with the AIS type of “cargo” may range in size from a deep draft container ship to a interisland landing craft



Spill Prevention, Preparedness, and Response Program

Developing the Vessel Movement Module:
Factors associated with track selection

More information

Visit our webpage

How you can help:

We are looking for feedback on factors that affect vessel tracks within our model area. Potential factors include:

- Vessel types
- Environmental conditions

Contact information
JD Ross Leahy
425-410-9806
jd.leahy@ecy.wa.gov

Special accommodations

To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-7668 or visit http://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Introduction

We have created this document to help support robust discussion around track selection factors, an important component of the first module we are developing as part of our Oil Spill Risk Model Development Project.

To learn more about the model we are building, and how track selection factors relate to the Vessel Movement Module (VMM) please review our Modeling Approach Focus Sheet.

Input on Track Selection Factors

We need your input on factors that influence the tracks vessels follow within the model area. A track is a series of sequential AIS messages with a start and end point, which represents the path that a vessel navigates. You can provide feedback by providing comments through our eComment system. We are also hosting a technical discussion of track selection factors October 21, 2020.

The VMM will generate simulated vessel data based on historical Automatic Identification System (AIS) data. We know vessel tracks vary – vessels do not always follow identical paths from an origin to a destination. We want to understand the factors that we can model that are important to this variation in tracks.

Factors that could influence track selection include the types of vessels, and other conditions such as wind, tide, current, and visibility.

Publication 20-08-014 November 2020 Page 1

Track Selection Factors: Vessel Type

Proposed list of vessel types

Assist/Escort Tug
ATB (Articulated Tug and Barge)
Bulk Carrier
Car Ferries
Container Ship
Crude Tanker
Cruise Ships
Fast Passenger Ferries
Fishing Vessel (<40m)
General/Other Cargo Ship
General/Other Cargo Vessel (<40m)
Large Fishing Vessel (>40m)
Large Rec. Vessel/Yacht (>40m)
Liquefied Gas Tanker
Mono-hull Passenger Ferries
Other/Unassigned
Other tugboats and workboats
Pilot Boat
Pocket Cruise Ship (>40m)
Product Tanker
Product Tanker – Bunkering
Rec. Vessel/ Yacht (<40m)
Research Vessel
Search/Mil/USCG (<40m)
Smaller Harbor Tug
Tanker/Chemical Tanker
Tour Vessel
Towing Vessel (Non-Oil)
Towing Vessel (Oil)
Towing Vessel (Oil) – Bunkering
Military/USCG Vessels (>40m)
Vehicle Carrier

Additions to proposed list of vessel types

Fishing Vessel (<40m)

- Commercial Fishing Vessel
- Tribal Fishing Vessel

Recreational Vessel/Yacht (<40m)

- Recreational Vessel/Yacht
- Sport Fishing Vessel

Tour Vessel

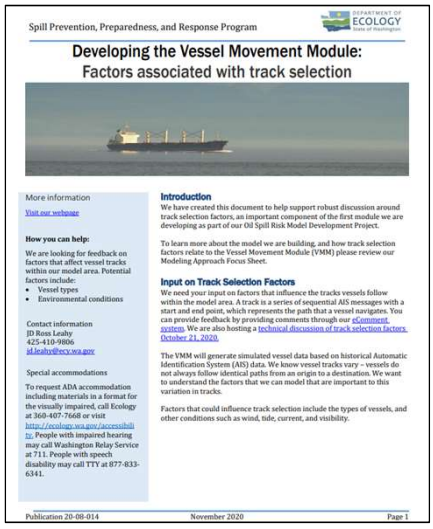
- Tour Vessel
- Whale Watching Vessel

17

Track Selection Factors: Others

Need to identify other potential factors in track selection:

- A list of potential factors
- Statistical hypothesis testing to determine influence on track selection



Spill Prevention, Preparedness, and Response Program

DEPARTMENT OF ECOLOGY State of Washington

Developing the Vessel Movement Module:
Factors associated with track selection

More information

Visit our webpage

How you can help:

We are looking for feedback on factors that affect vessel tracks within our model area. Potential factors include:

- Vessel types
- Environmental conditions

Contact information
JD Ross Leahy
425-410-9806
jd.leahy@ecy.wa.gov

Special accommodations

To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-7668 or visit http://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Introduction

We have created this document to help support robust discussion around track selection factors, an important component of the first module we are developing as part of our Oil Spill Risk Model Development Project.

To learn more about the model we are building, and how track selection factors relate to the Vessel Movement Module (VMM) please review our Modeling Approach Focus Sheet.

Input on Track Selection Factors

We need your input on factors that influence the tracks vessels follow within the model area. A track is a series of sequential AIS messages with a start and end point, which represents the path that a vessel navigates. You can provide feedback by providing comments through our eComment system. We are also hosting a technical discussion of track selection factors October 21, 2020.

The VMM will generate simulated vessel data based on historical Automatic Identification System (AIS) data. We know vessel tracks vary – vessels do not always follow identical paths from an origin to a destination. We want to understand the factors that we can model that are important to this variation in tracks.

Factors that could influence track selection include the types of vessels, and other conditions such as wind, tide, current, and visibility.

Publication 20-08-014 November 2020 Page 1

18

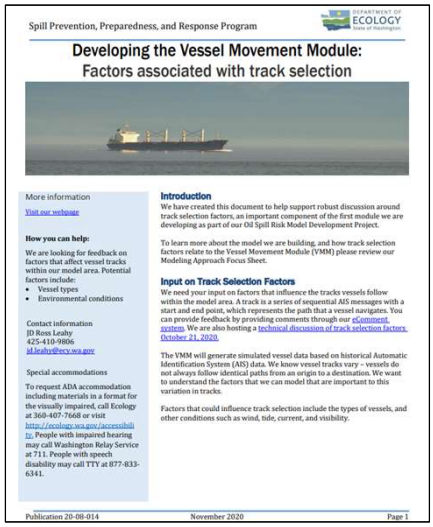
Track Selection Factors: Others

Proposed list of factors

- Current/tide
- Wind
- Sea state
- Time of day
- Visibility

Additions to proposed list

- Presence of a fishing opener
- Presence of a tug escort
- Day of the week
- Domestic vs International Flag



Spill Prevention, Preparedness, and Response Program

Developing the Vessel Movement Module:
Factors associated with track selection

More information
Visit our webpage

How you can help:
We are looking for feedback on factors that affect vessel tracks within our model area. Potential factors include:
- Vessel types
- Environmental conditions

Contact information
JD Ross Leahy
425-410-9806
jd.leahy@ecy.wa.gov

Special accommodations
To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-7668 or visit http://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Introduction
We have created this document to help support robust discussion around track selection factors, an important component of the first module we are developing as part of our Oil Spill Risk Model Development Project.

To learn more about the model we are building, and how track selection factors relate to the Vessel Movement Module (VMM) please review our Modeling Approach Focus Sheet.

Input on Track Selection Factors
We need your input on factors that influence the tracks vessels follow within the model area. A track is a series of sequential AIS messages with a start and end point, which represents the path that a vessel navigates. You can provide feedback by providing comments through our eComment system. We are also hosting a technical discussion of track selection factors October 21, 2020.

The VMM will generate simulated vessel data based on historical Automatic Identification System (AIS) data. We know vessel tracks vary – vessels do not always follow identical paths from an origin to a destination. We want to understand the factors that we can model that are important to this variation in tracks.

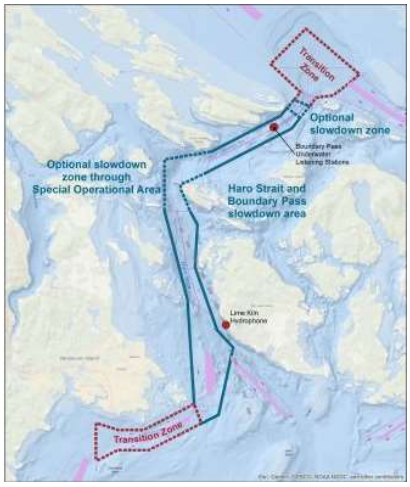
Factors that could influence track selection include the types of vessels, and other conditions such as wind, tide, current, and visibility.

Publication 20-08-014 November 2020 Page 1

Rules That May Affect Vessel Movements

The VMM needs to represent:

- New rules that might not be apparent in the historical data
- Rules that only come into effect during certain times of the year
- Rules that are based on vessel interactions, i.e. only come into play under specific circumstances



Rules That May Affect Vessel Movements

Proposed rules for inclusion in VMM:

- Turn Point Special Operating Area
- Eastern San Juan Island Archipelago VTS Special Area Regulations
- Echo Program Voluntary Vessel Slowdown for Haro Strait and Boundary Pass
- Echo Program Strait of Juan de Fuca Voluntary Inshore Lateral Displacement
- Transport Canada Interim Sanctuary Zones
- Swiftsure Bank Voluntary Ship Slowdown Trial

Spill Prevention, Preparedness, and Response Program

DEPARTMENT OF ECOLOGY State of Washington

Developing the Vessel Movement Module: Rules that may affect vessel movements

More information
Visit our webpage

How you can help:

We are looking for feedback on this draft approach from all stakeholders, especially those with expertise and interest in:

- Specific Salish Sea navigation rules and restrictions whose impact is not necessarily apparent in historical data
- Vessel decision making around specific Salish Sea navigation rules and restrictions

Contact information

JD Ross Leahy
425-410-9806
jd.leahy@ecy.wa.gov

Special accommodations

To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-7668 or visit http://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Introduction

This focus sheet describes our approach to modeling rules that may affect vessel movements within our oil spill risk model. We're seeking your input on this draft approach.

Our draft list of rules to include in the model are shown on page 2, along with questions that may help you provide your thoughts.

You can provide feedback using our eComment system. We are also hosting a technical discussion of rules affecting vessel movements October 27, 2020.

To learn more about the model we are building, and how rules that may affect vessel movements relate to the Vessel Movement Module (VMM) please review our Modeling Approach focus sheet.

Rules that may affect vessel movements

Vessels operating in the Salish Sea are governed by many international, US and Canadian regulations. These rules, in addition to other factors, result in the patterns of vessel movements that we see in historical AIS data. For instance, larger vessels generally operate within established traffic lanes, and avoid separation zones. Vessel operators use collision avoidance rules to guide their decision making when negotiating passing arrangements.

Our Vessel Movement Module is based on historical AIS data. By incorporating the tracks vessels have taken, the model implicitly includes the results of vessels following rules governing how and where vessels operate. Our model will include multiple years of AIS data, which makes it likely that we will also incorporate some examples of vessels that are not following the rules.

Publication 20-08-016 October 2020 Page 1

Movements Associated With Other Vessels

Dependent Vessels

- Vessels whose movements are dependent on the arrival or existence of another vessel, e.g.
  - Tug boats providing escorts
  - Pilot boats delivering or retrieving pilots
  - Vessels delivering bunkers

Dependent Vessels

Proposed list of dependent vessels

- Vessels providing bunkers
- Escort tugs
- Assist tugs
- Pilot boats

Additions to proposed list

- Crew boats
- Submarine escorts

Spill Prevention, Preparedness, and Response Program

Developing the Vessel Movement Module: Movements associated with other vessels

More information
Visit our webpage

How you can help:
We are looking for feedback on this draft approach from tribes and stakeholders, especially those with expertise and interest in the operational patterns for vessels that provide services to other vessels, such as:
-Bunkering
-Escort tugs
-Assist tugs
-Pilot boats

Contact information
JD Ross Leahy
425-410-9806
jd.leahy@ecy.wa.gov

Special accommodations
To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-7668 or visit http://ecology.wa.gov/accessibility.com. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Introduction
This focus sheet describes our approach to modeling vessel movements that are associated with the movements of other vessels. We are seeking your input on this draft approach.

Our draft list of vessel types whose movements are linked to other vessels is shown on the left. On page 2, we have included questions that may help you provide your thoughts.

You can provide feedback using our eComment system. We are also hosting a technical discussion of rules affecting vessel movements October 29, 2020.

To learn more about the model we are building, and how these types of vessel movements relate to the Vessel Movement Module (VMM) please review our Modeling Approach focus sheet.

Vessel movements associated with other vessels
As part of our development of the Vessel Movement Module, we need to determine how to represent vessels whose movements are dependent on the behavior of other vessels. For instance, escort tugs only run out to escort a tanker if a tanker is arriving, and bunkers are only delivered to anchorages that are occupied by vessels in need of bunkers.

To represent this type of dependent vessel movement, we cannot solely rely on AIS data. We need to produce a series of rules that outline which vessels need escorts, pilots, and bunkers, where they need them, and when. In addition, we have to come up with a strategy for representing the movements of the dependent vessels before and after they provide their service – where did they come from and where are they going.

Publication 20-08-017 October 2020 Page 1

Vessels That Do Not Transmit Via AIS

Who isn't required to carry AIS?

- Recreational vessels
  - Sailboats
  - Yachts
- Commercial vessels under 65 feet
  - Whale watching vessels
  - Fishing vessels
- Towing Vessels under 26 feet

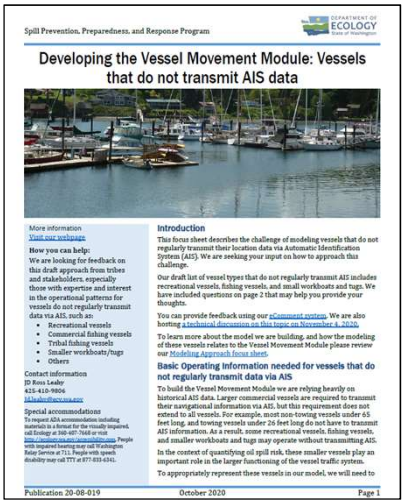
Vessels Not Represented in AIS

Proposed list of non-AIS Vessels

- Recreational vessels
- Commercial fishing vessels
- Small workboats/tugs

Additions to proposed list

- Navy and other military vessels
- Tribal fishing vessels
- Sport fishing vessels



Spill Prevention, Preparedness, and Response Program

Developing the Vessel Movement Module: Vessels that do not transmit AIS data

More information
Visit our webpage.

How you can help:
We are looking for feedback on this draft approach from tribes and stakeholders, especially those with expertise and interest in the operational patterns for vessels do not regularly transmit data via AIS, such as:

- Recreational vessels
- Commercial fishing vessels
- Tribal fishing vessels
- Smaller workboats/tugs
- Others

Contact information
JD Ross Leahy
425-410-9806
JRLeahy@ecy.wa.gov

Special accommodations
To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-7668 or visit http://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Introduction

This focus sheet describes the challenge of modeling vessels that do not regularly transmit their location data via Automatic Identification System (AIS). We are seeking your input on how to approach this challenge.

Our draft list of vessel types that do not regularly transmit AIS includes recreational vessels, fishing vessels, and small workboats and tugs. We have included questions on page 2 that may help you provide your thoughts.

You can provide feedback using our eComment system. We are also hosting a technical discussion on this topic on November 4, 2020.

To learn more about the model we are building, and how the modeling of these vessels relates to the Vessel Movement Module please review our Modeling Approach focus sheet.

Basic Operating Information needed for vessels that do not regularly transmit data via AIS

To build the Vessel Movement Module we are relying heavily on historical AIS data. Larger commercial vessels are required to transmit their navigational information via AIS, but this requirement does not extend to all vessels. For example, most non-towing vessels under 65 feet long, and towing vessels under 26 feet long do not have to transmit AIS information. As a result, some recreational vessels, fishing vessels, and smaller workboats and tugs may operate without transmitting AIS.

In the context of quantifying oil spill risk, these smaller vessels play an important role in the larger functioning of the vessel traffic system.

To appropriately represent these vessels in our model, we will need to

Publication 20-08-019 October 2020 Page 1

Other suggestions currently tabled

Track Selection Factors

- Whale sightings reported via WRAS

Rules

- COLREGs (Rules of the road)
- Traffic Separation Scheme
- New Commercial Whale Watch Rules

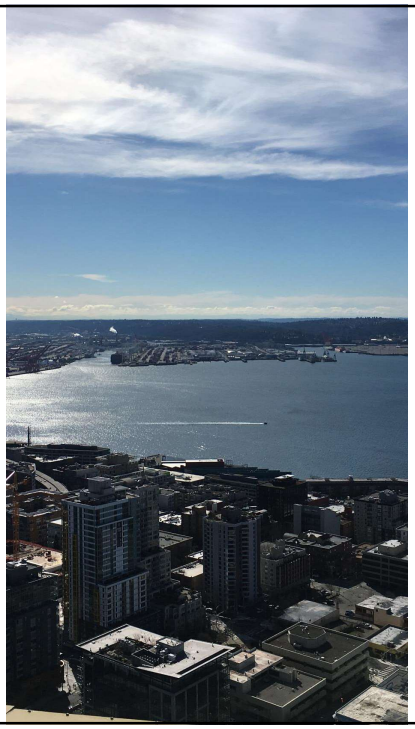
Dependent Vessel Movements

- Boom Boats
- Seine Skiffs

VMM Development Progress

Adjustments to Routing Strategy

- Route based vs non-route based vessels
- Identification of route segments and waypoints
- Concept of vessel journey and journey network



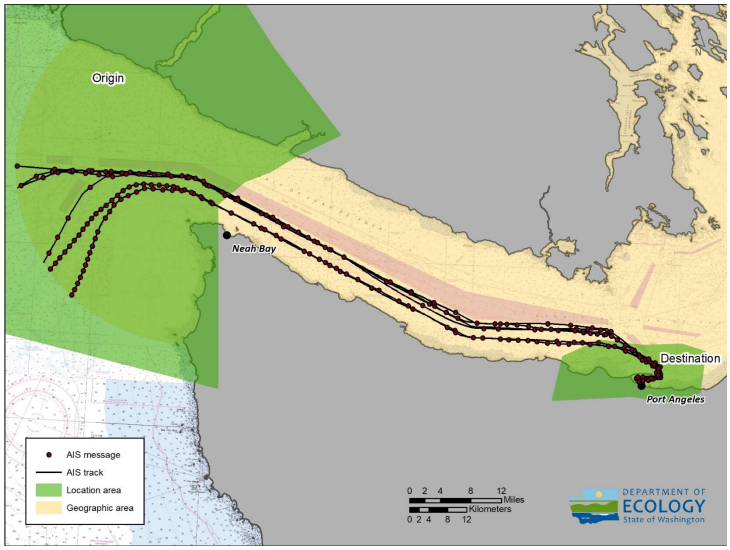
27

Route Identification

Many vessels share common origins and destinations

Each has a unique track

A route = a collection of tracks with the same origin and destination



28

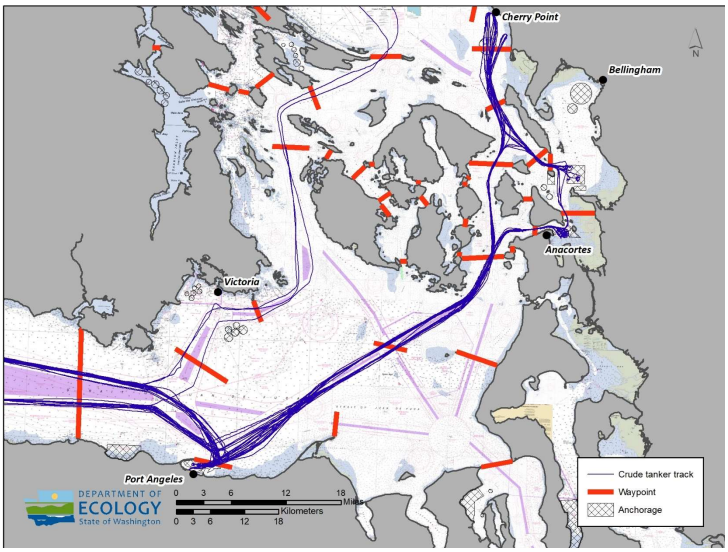
Complex Routes

Only certain vessel types operate on replicable routes

Breaking routes down into segments allows improved simulation flexibility

Separate vessels by route type

Identify route nodes



29

Separate Vessels by Route Type

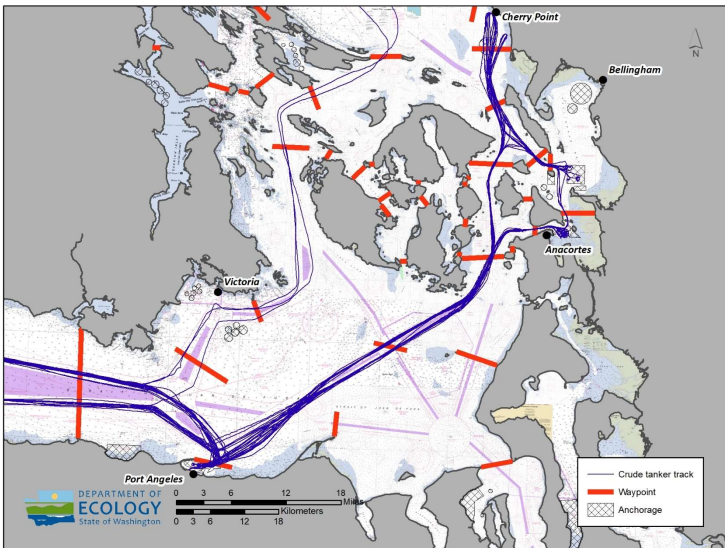
Route Based Vessels	Partially Route Based Vessels	Non-Route Based Vessels
- ATB - Bulk Carrier - Container Ship - Crude Tanker - Cruise Ship - General/Other Cargo Ship - Large Fishing Vessel (>40m) - Liquefied Gas Tanker - Product Tanker - Tanker/Chemical Tanker - Vehicle Carrier	- Large Recreational Vessel/Yacht - Military/USCG Vessel - Pocket Cruise Ship - Product Tanker – Bunkering - Towing Vessel (Non-Oil) - Towing Vessel (Oil) - Towing Vessel (Oil) – Bunkering	- Assist/Escort Tug - Fishing Vessel - General/Other Cargo Vessel - Other - Other tugboat or workboat - Pilot Boat - Recreational Vessel/ Yacht - Research Vessel - Search and Rescue/Military/USCG - Smaller Harbor Tug - Sport Fishing - Tour Vessel - Tribal Fishing - Whale and Wildlife Watching

30

Identify Route Waypoints

Waypoints are the intersections along a route

Identified waypoints are now included in our list of origins and destinations

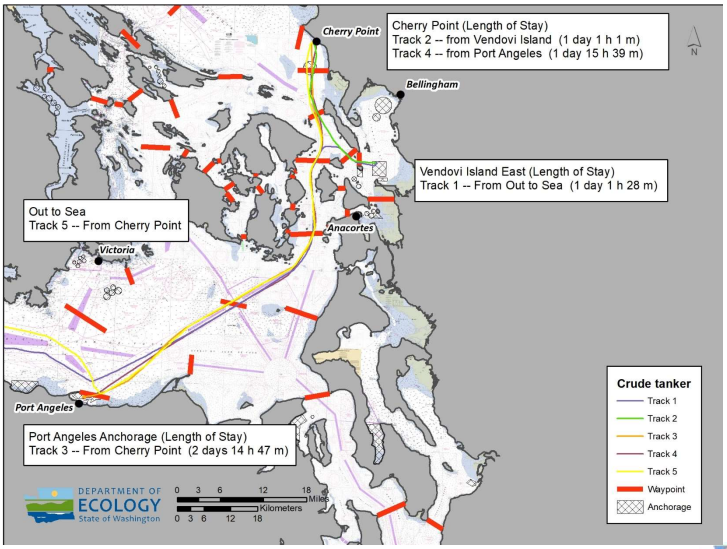


Vessel Journey and Journey Network

Vessel Journey starts when a vessel enters the model geographic area, and ends upon departure.

Vessel Journey Network is a collection of route segments connected by waypoints.

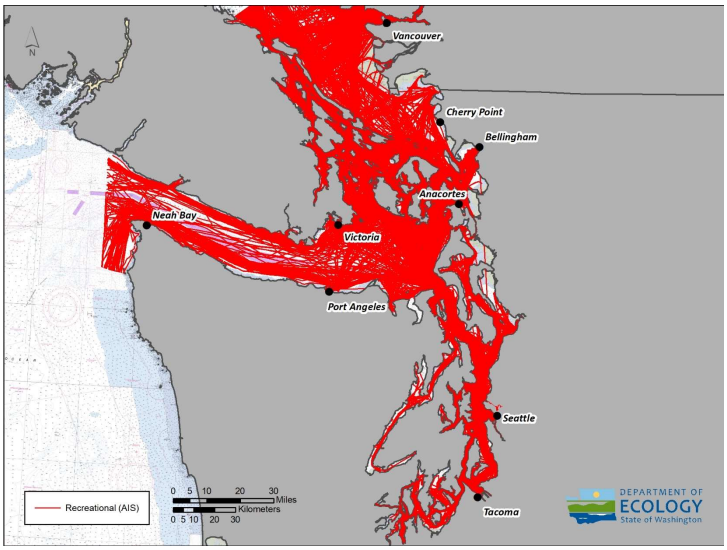
Time at anchor or facility is incorporated as a unique part of Vessel Journey.



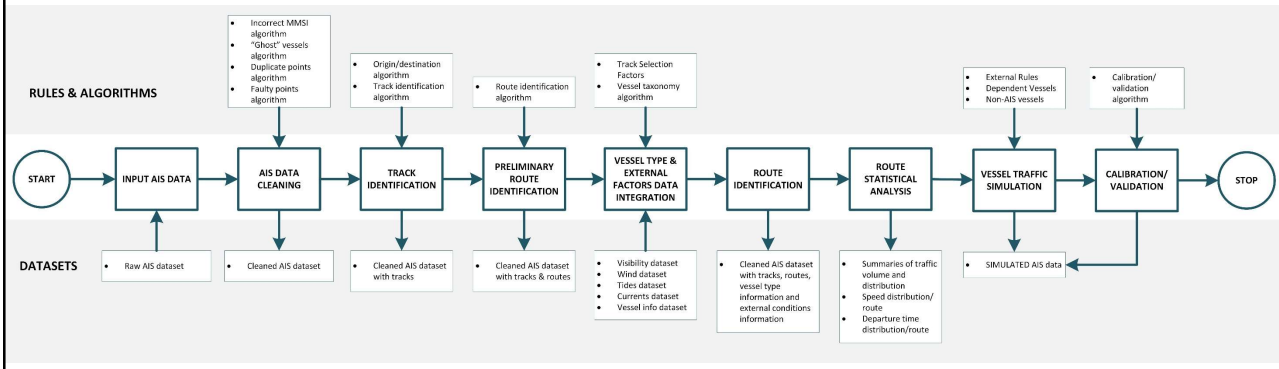
Non Route Based Vessels

Potential modeling strategies:

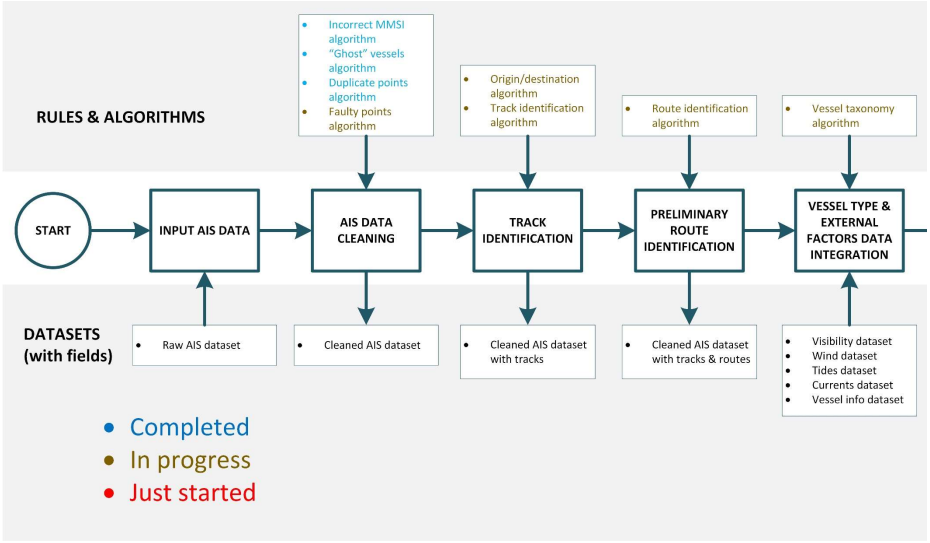
- Clusters of points in specific locations
- Manually created movements to and from clusters
- Identification and simulation on tracks without combining into routes



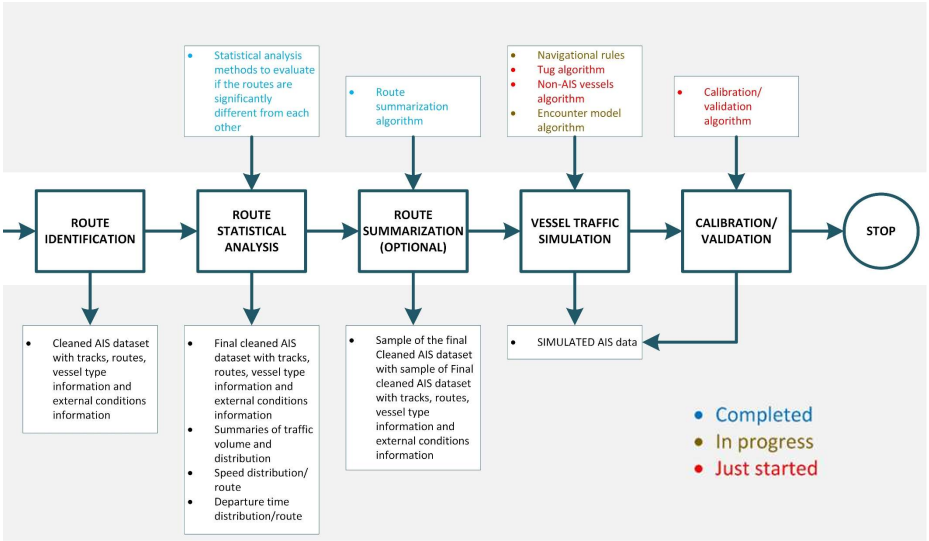
VMM Progress and Next Steps Summary



VMM Progress and Next Steps Summary (1st Half)



VMM Progress and Next Steps Summary (2nd Half)

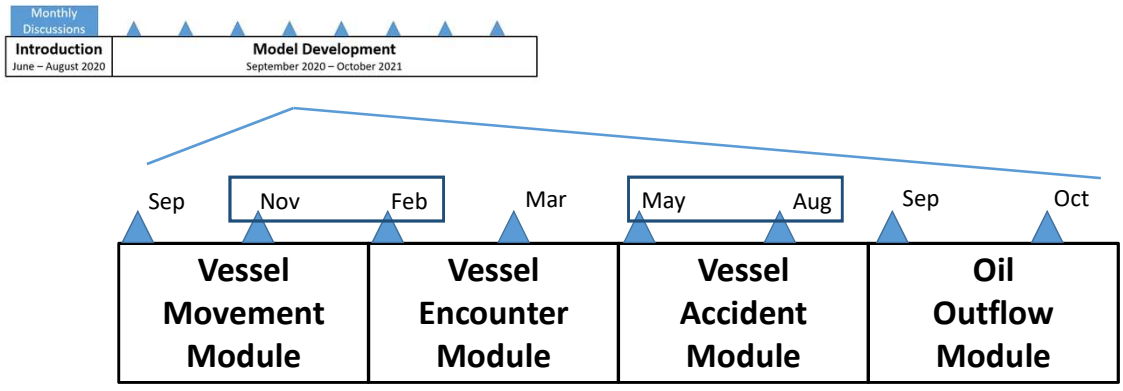


Additional feedback opportunities on VMM

Module Description Document

- Comprehensive description of each module
- Draft documents will be posted to the webpage for comments and feedback

Webinars and Technical Discussions



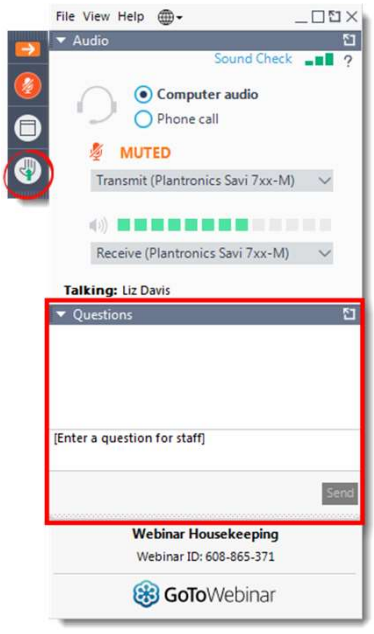
Upcoming events

February 10th, 2021 -- 1 pm to 3 pm

- Presentation on Vessel Encounter Module

39

Discussion logistics



40

Today's discussion topics

- Feedback or comments on recent technical discussion sessions
- Current status of our work on the vessel movement module
- Ways to improve upcoming webinars and discussions related to Vessel Encounter Module

Contact Info

JD Ross Leahy
Maritime Risk Modeling Specialist
Prevention Section

Spill Prevention, Preparedness, and Response Program

jd.leahy@ecy.wa.gov
Work Cell: 425-410-9806