Model 101: A Review of Model Structure

June 30th, 2021

Model Development Team

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Today's outline

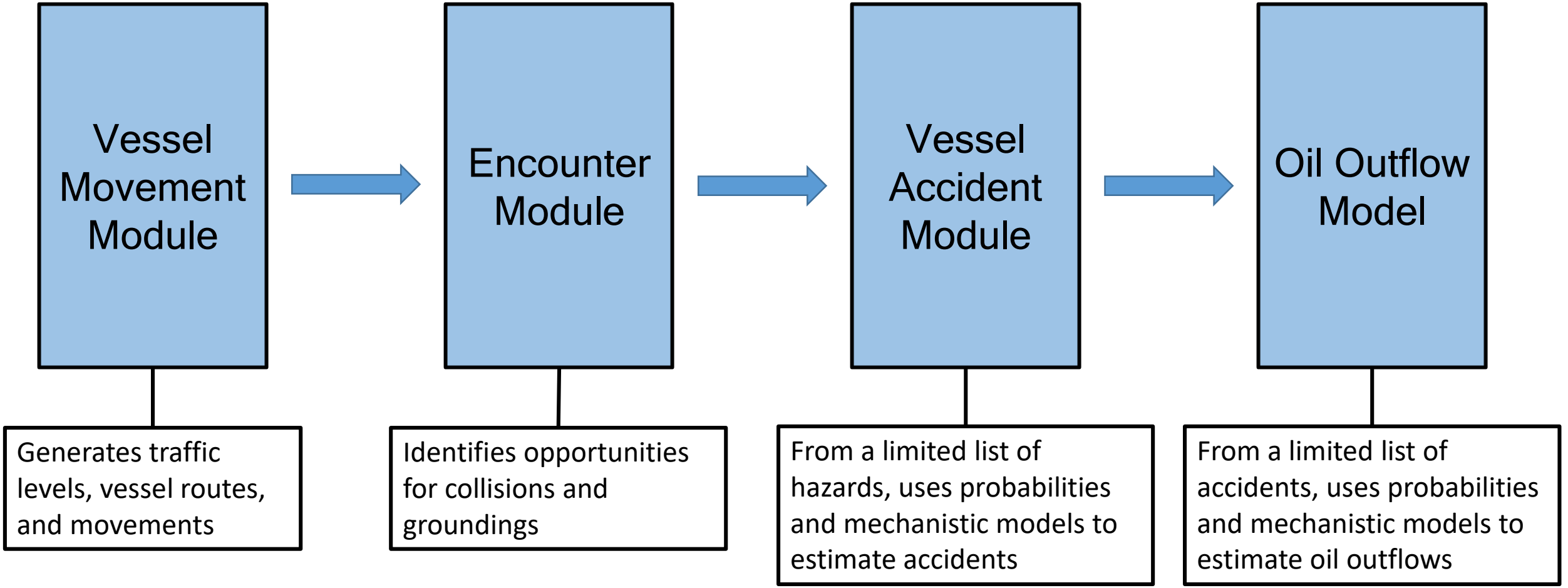
1. **Modeling Approach**
2. **Vessel Movements**
3. **Incident Simulation**
4. **Vessel Interactions**
5. **Discussion**

Legislative background

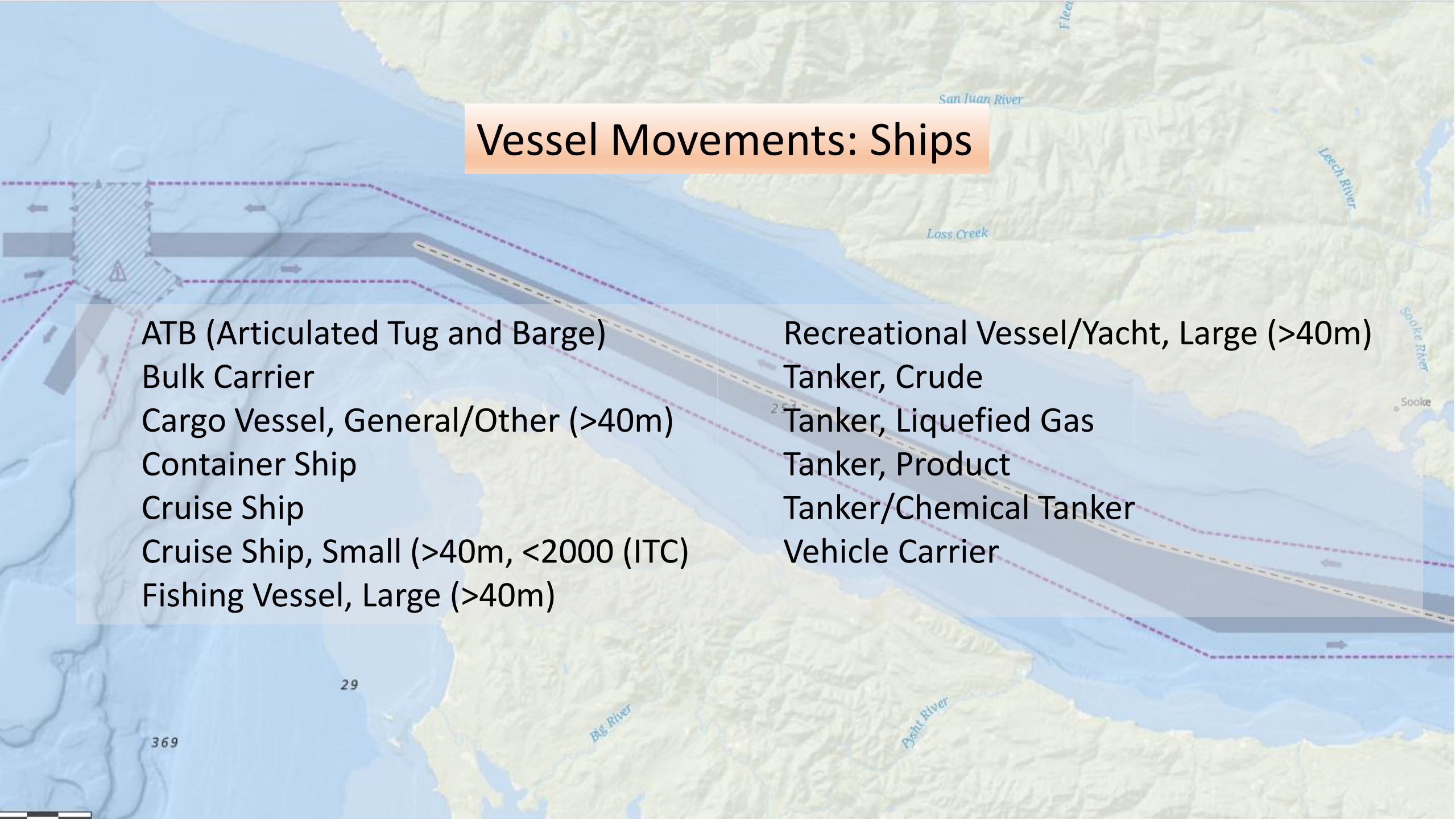
- ESHB 1578 was passed in 2019 to reduce the risk of oil spills, and protect Southern Resident Killer Whales

- 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

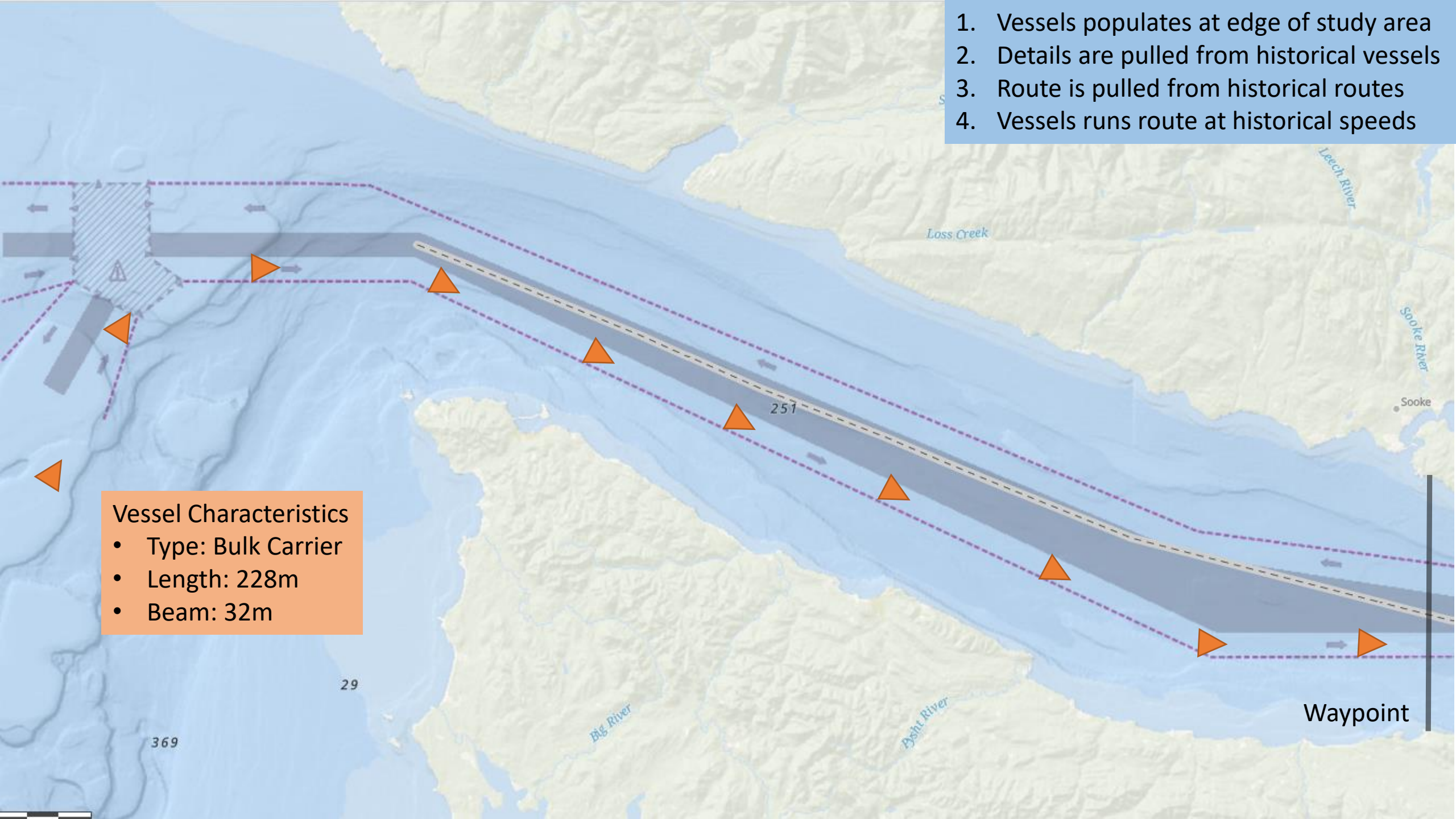
Modeling Approach



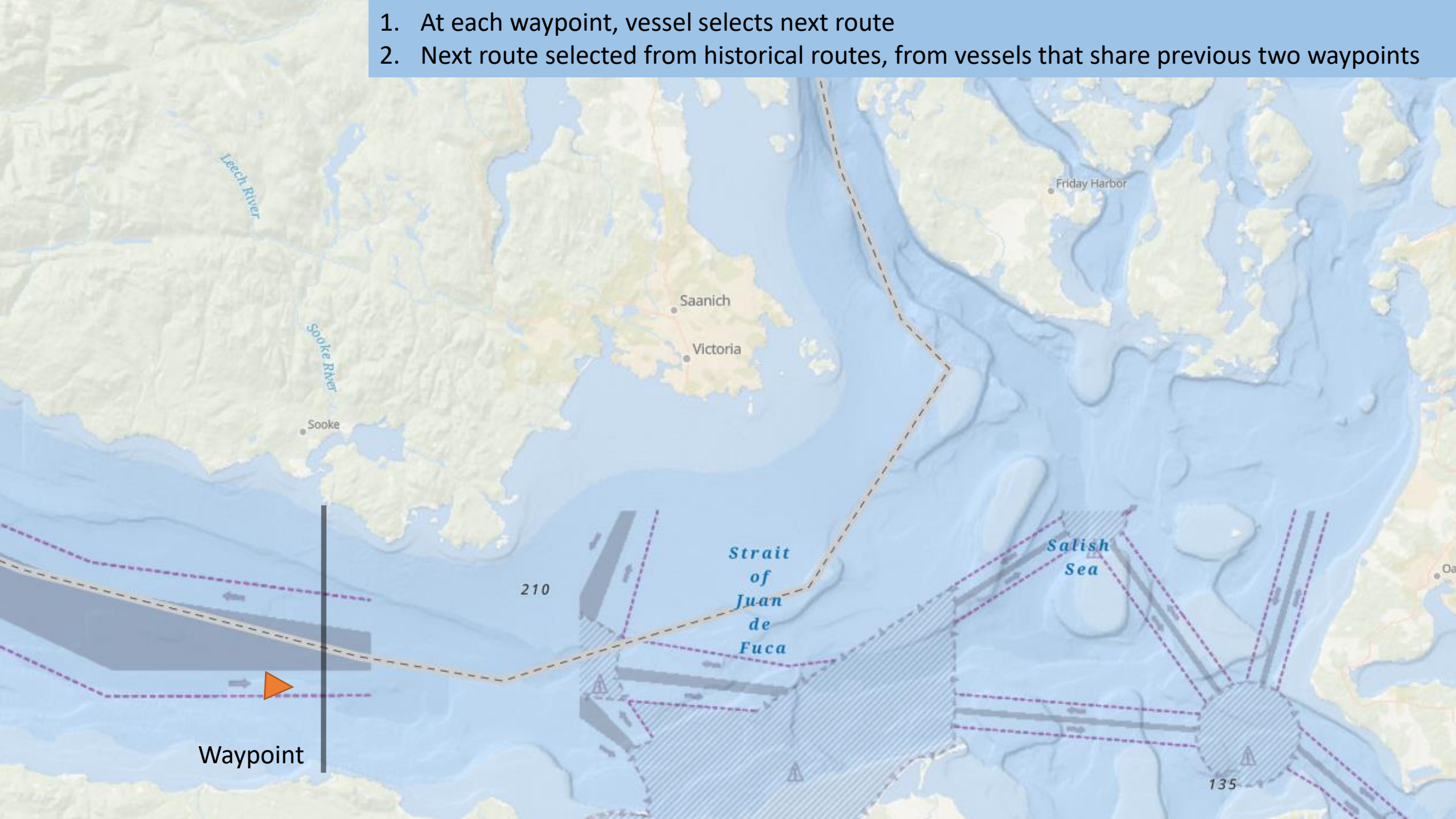
Vessel Movements: Ships



ATB (Articulated Tug and Barge)
Bulk Carrier
Cargo Vessel, General/Other (>40m)
Container Ship
Cruise Ship
Cruise Ship, Small (>40m, <2000 (ITC)
Fishing Vessel, Large (>40m)
Recreational Vessel/Yacht, Large (>40m)
Tanker, Crude
Tanker, Liquefied Gas
Tanker, Product
Tanker/Chemical Tanker
Vehicle Carrier


1. Vessels populates at edge of study area
2. Details are pulled from historical vessels
3. Route is pulled from historical routes
4. Vessels runs route at historical speeds
Vessel Characteristics
• Type: Bulk Carrier
• Length: 228m
• Beam: 32m
Waypoint
Loss Creek
Leech River
Spoke River
Sooke
251
29
369
Big River
Pysht River

1. At each waypoint, vessel selects next route
2. Next route selected from historical routes, from vessels that share previous two waypoints



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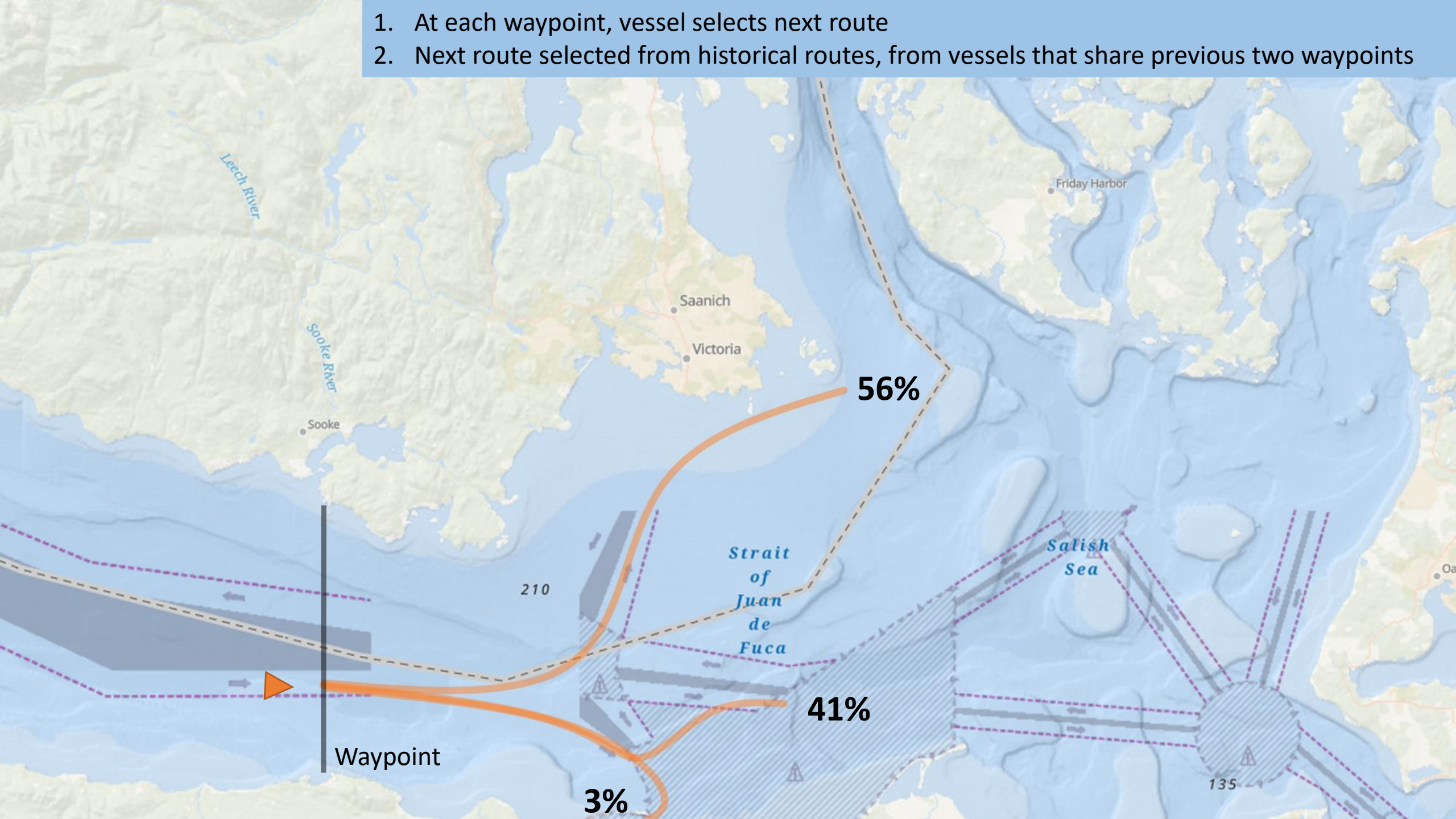
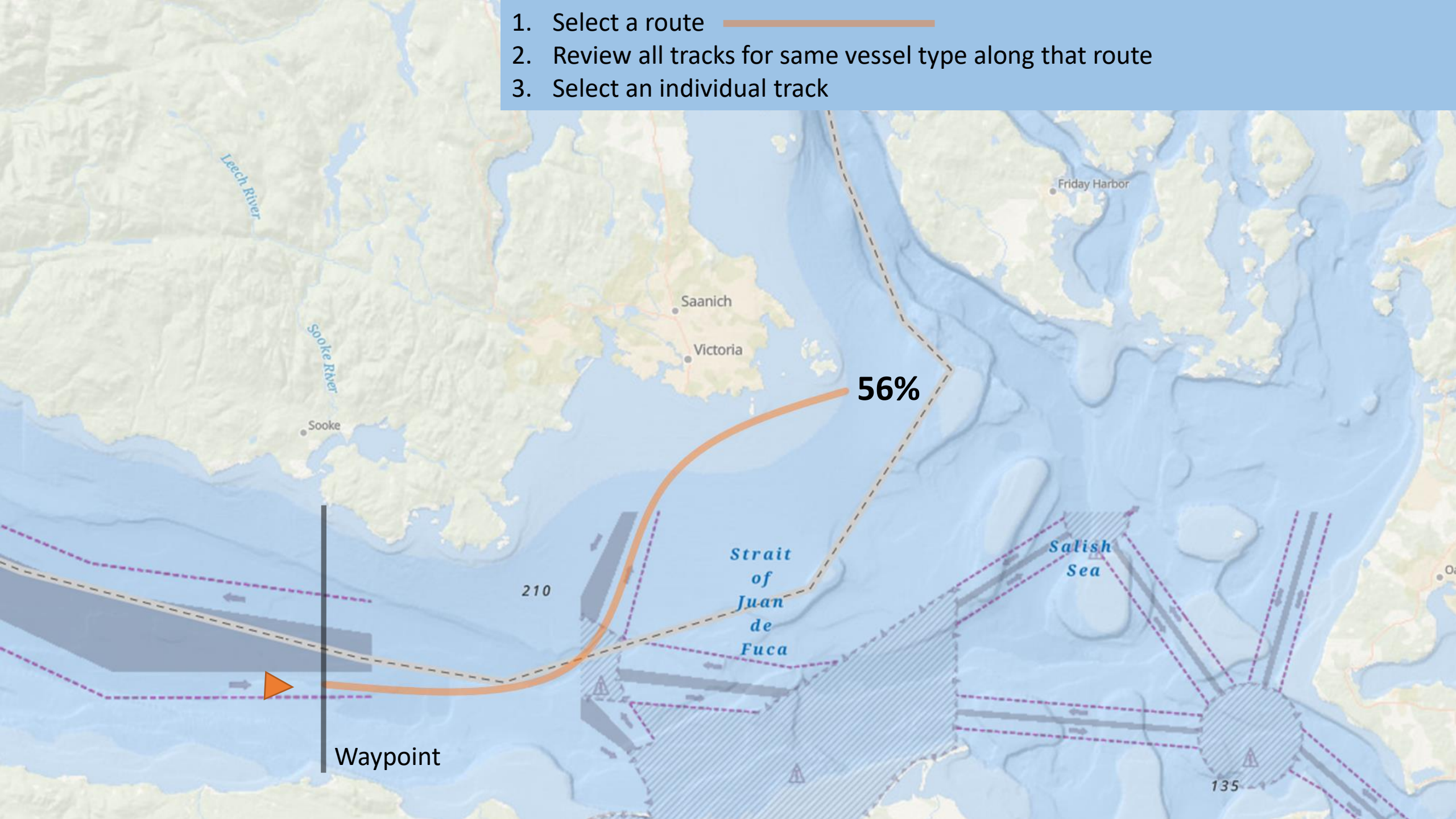
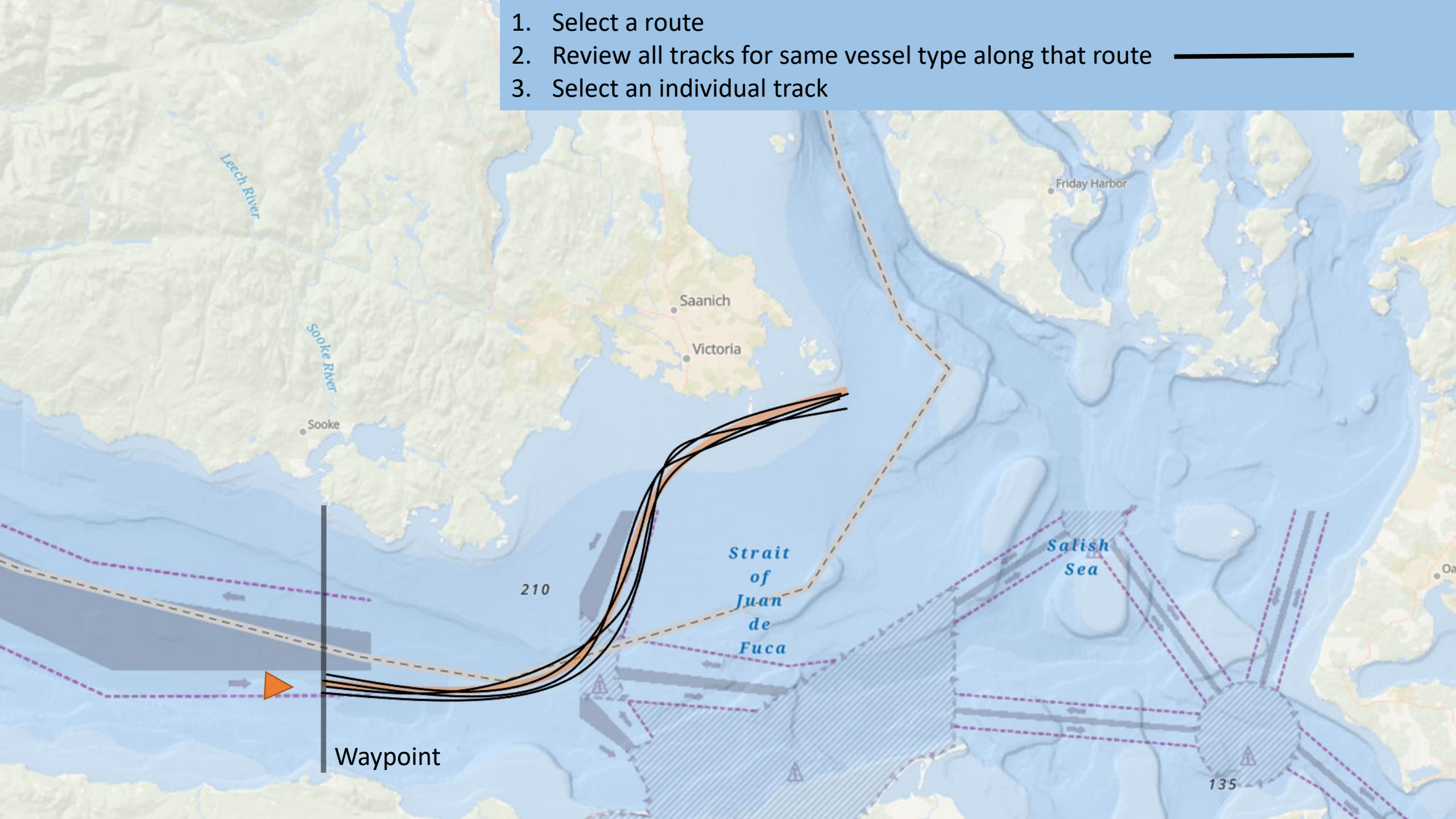


1. Select a route
2. Review all tracks for same vessel type along that route
3. Select an individual track



1. Select a route
2. Review all tracks for same vessel type along that route
3. Select an individual track



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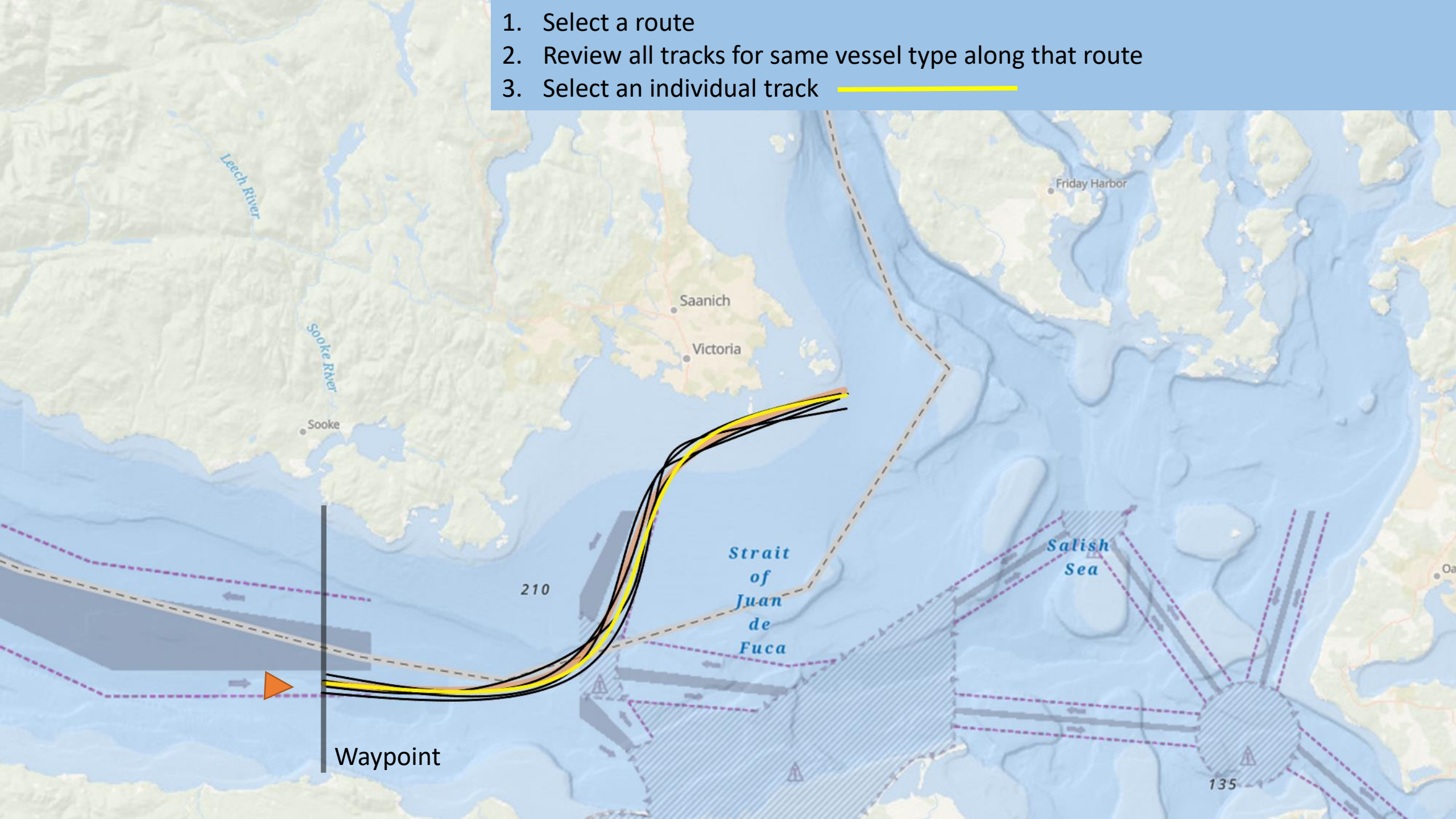
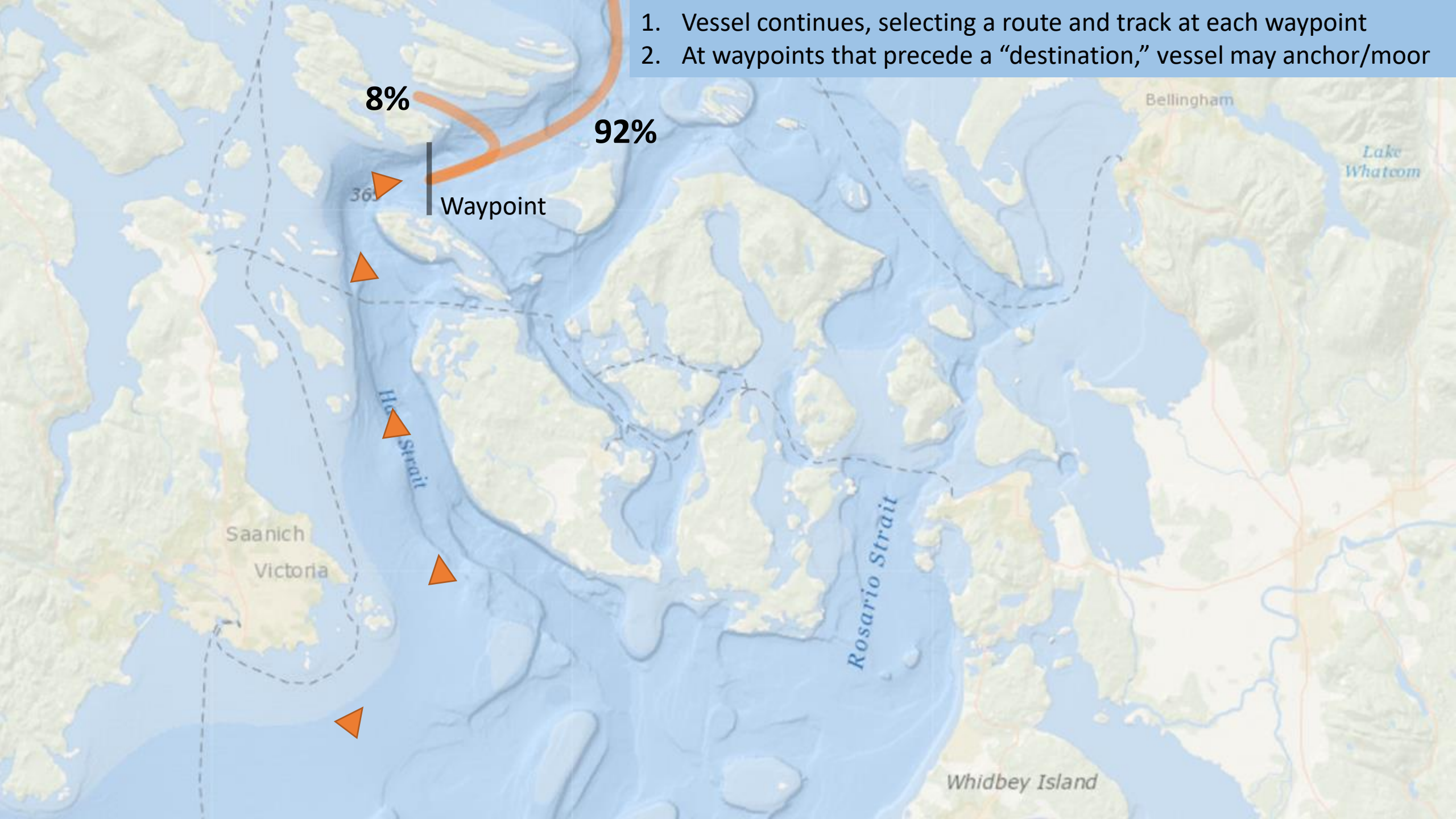
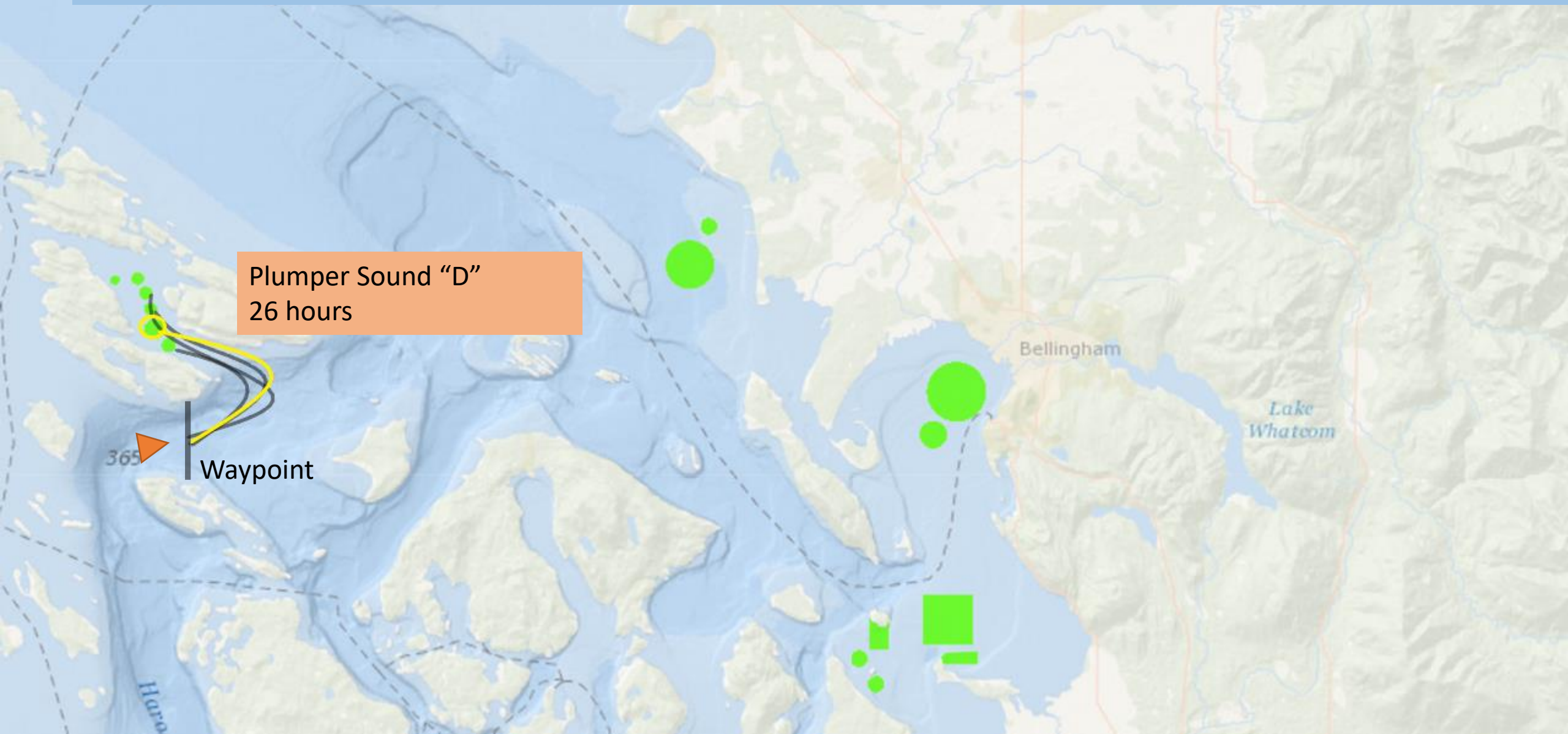


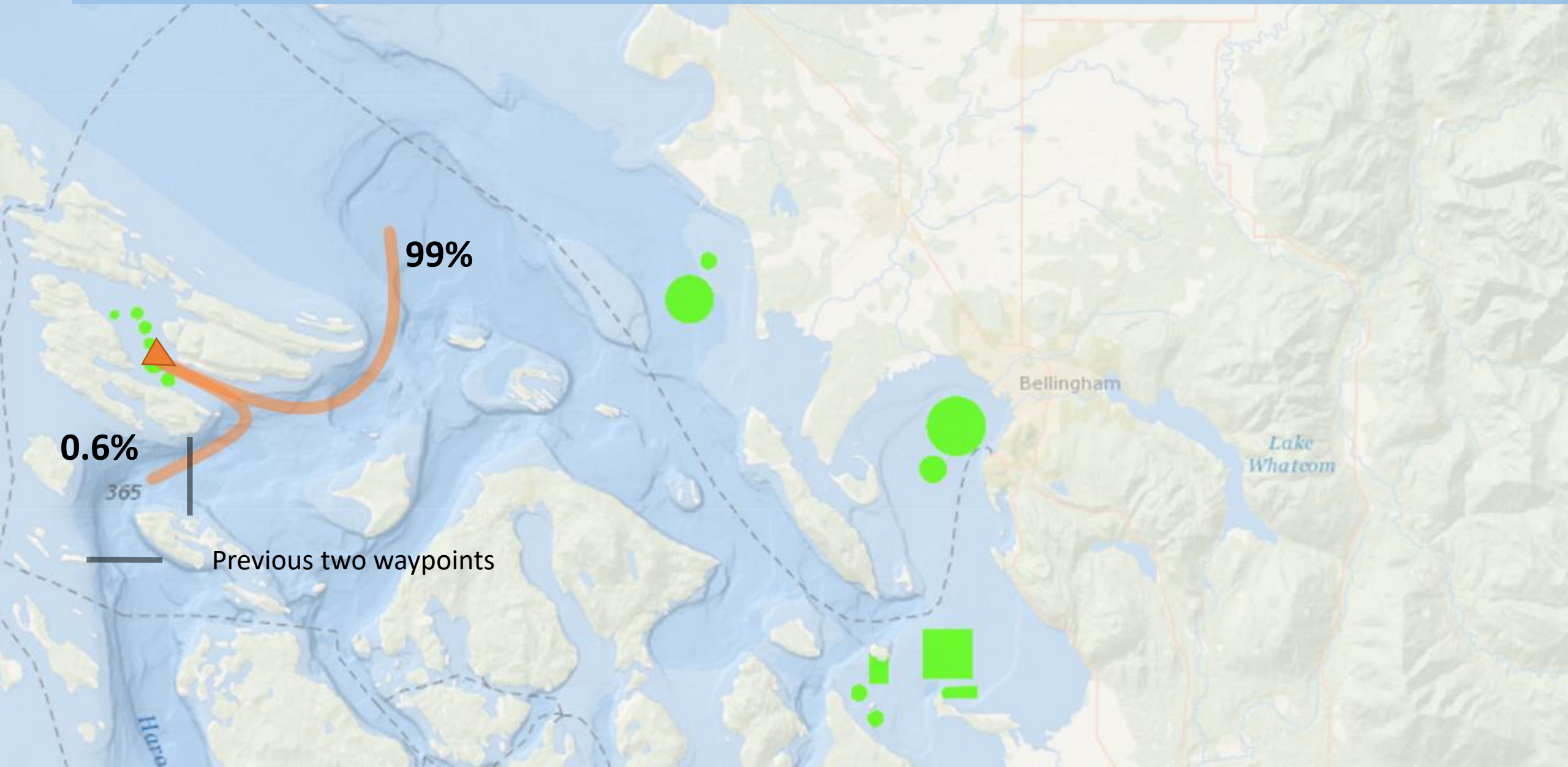
1. Vessel continues, selecting a route and track at each waypoint
2. At waypoints that precede a “destination,” vessel may anchor/moor

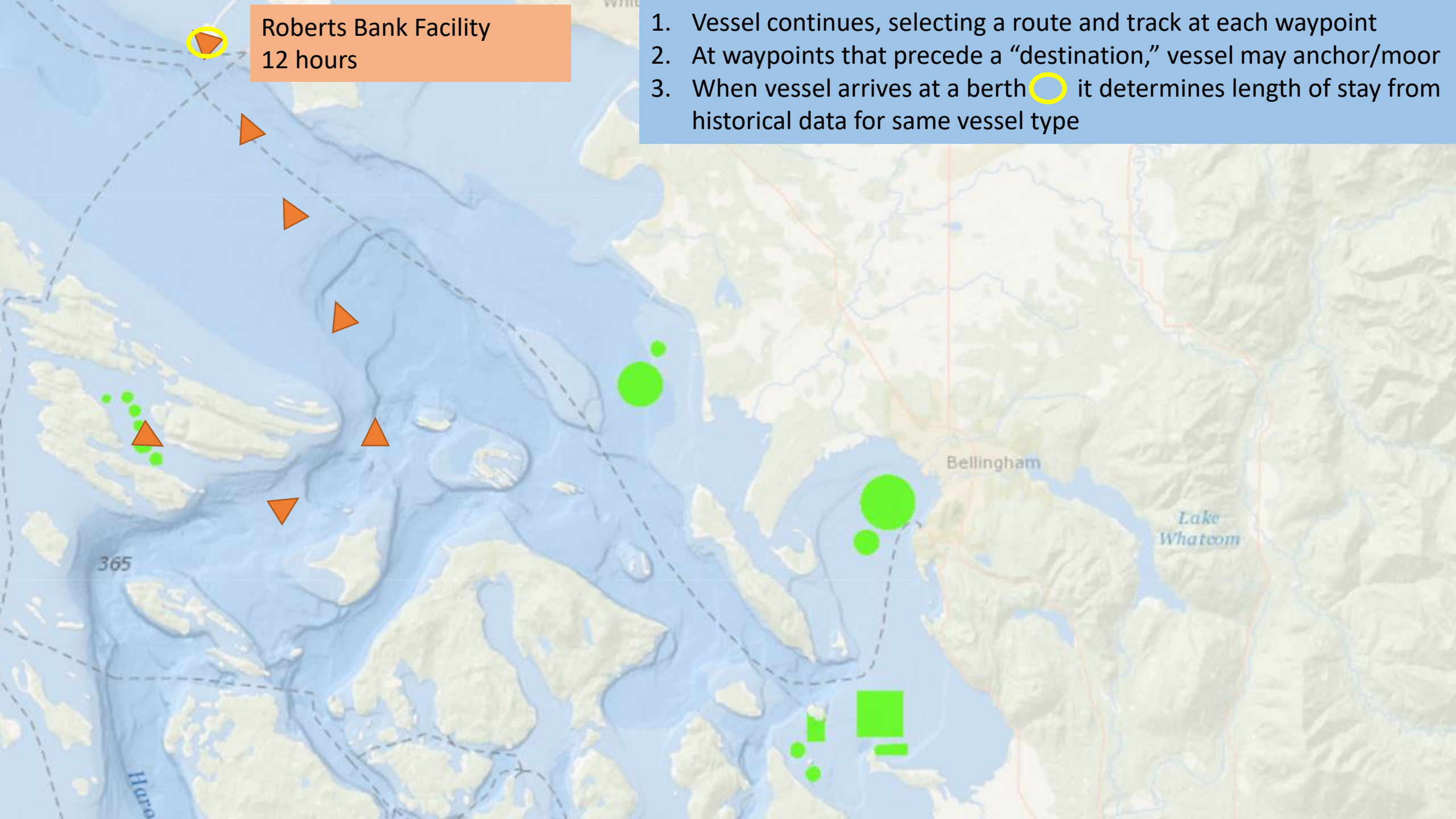


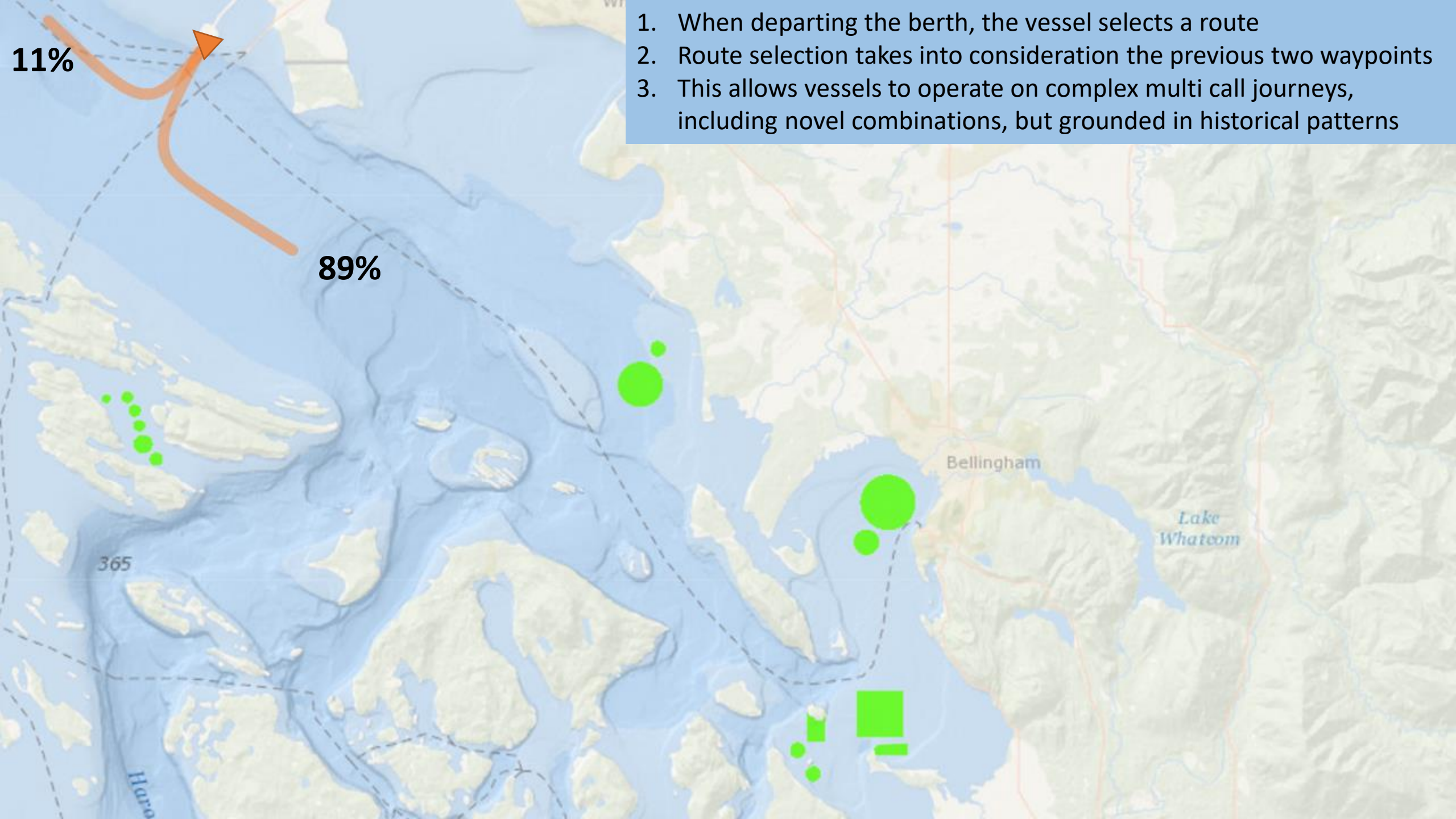
1. The individual tracks ——— may lead to different anchorage locations
2. When vessel arrives at an anchorage ○ it determines length of stay from historical data for same vessel type
3. The vessel only anchors at available anchorages
4. If an anchorage is occupied, the vessel selects a different track leading to a different anchorage



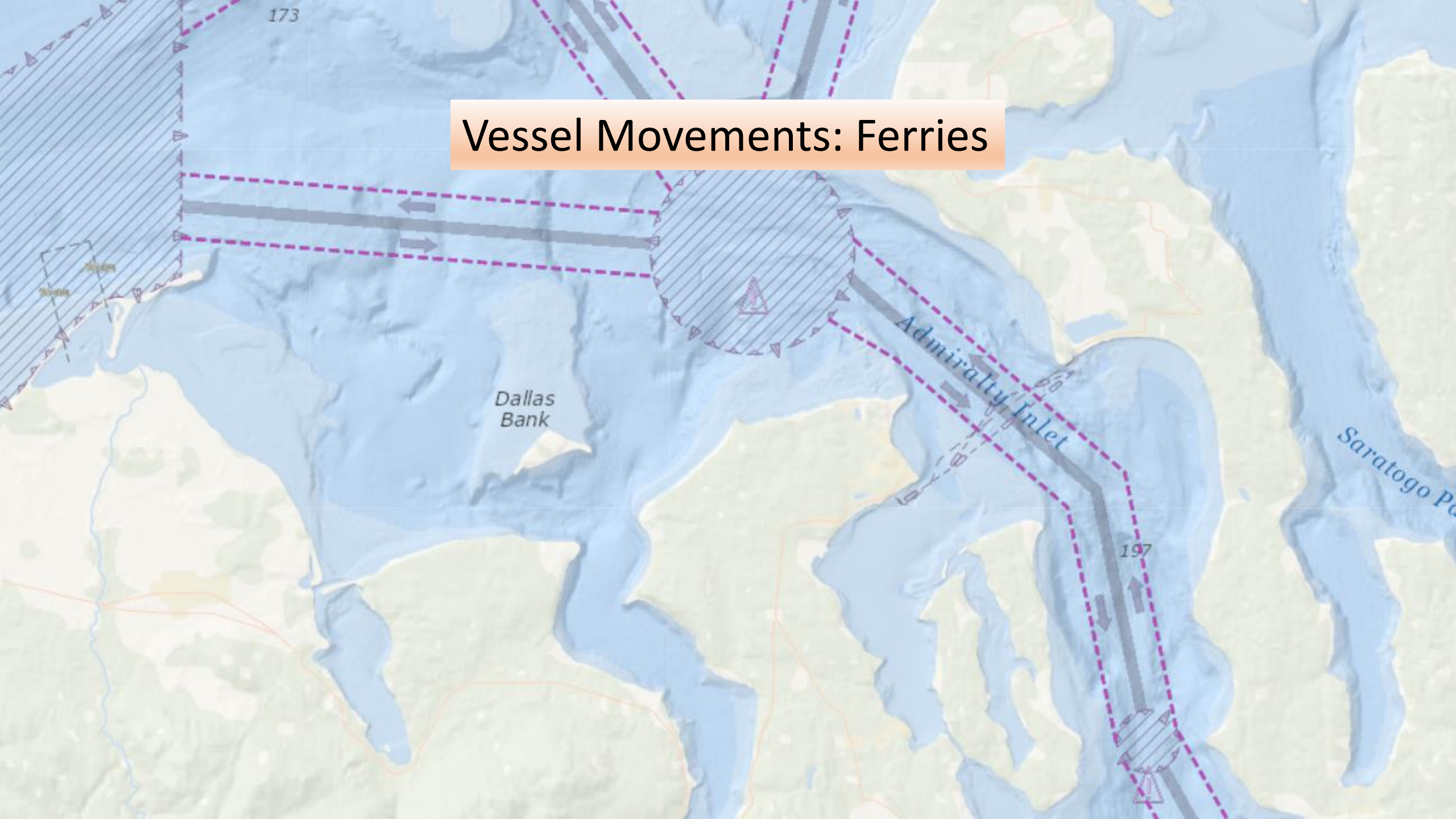
1. When departing the anchorage, the vessel selects a route
2. Route selection takes into consideration the previous two waypoints
3. This prevents vessels from illogically “turning around,” unless historical vessels did



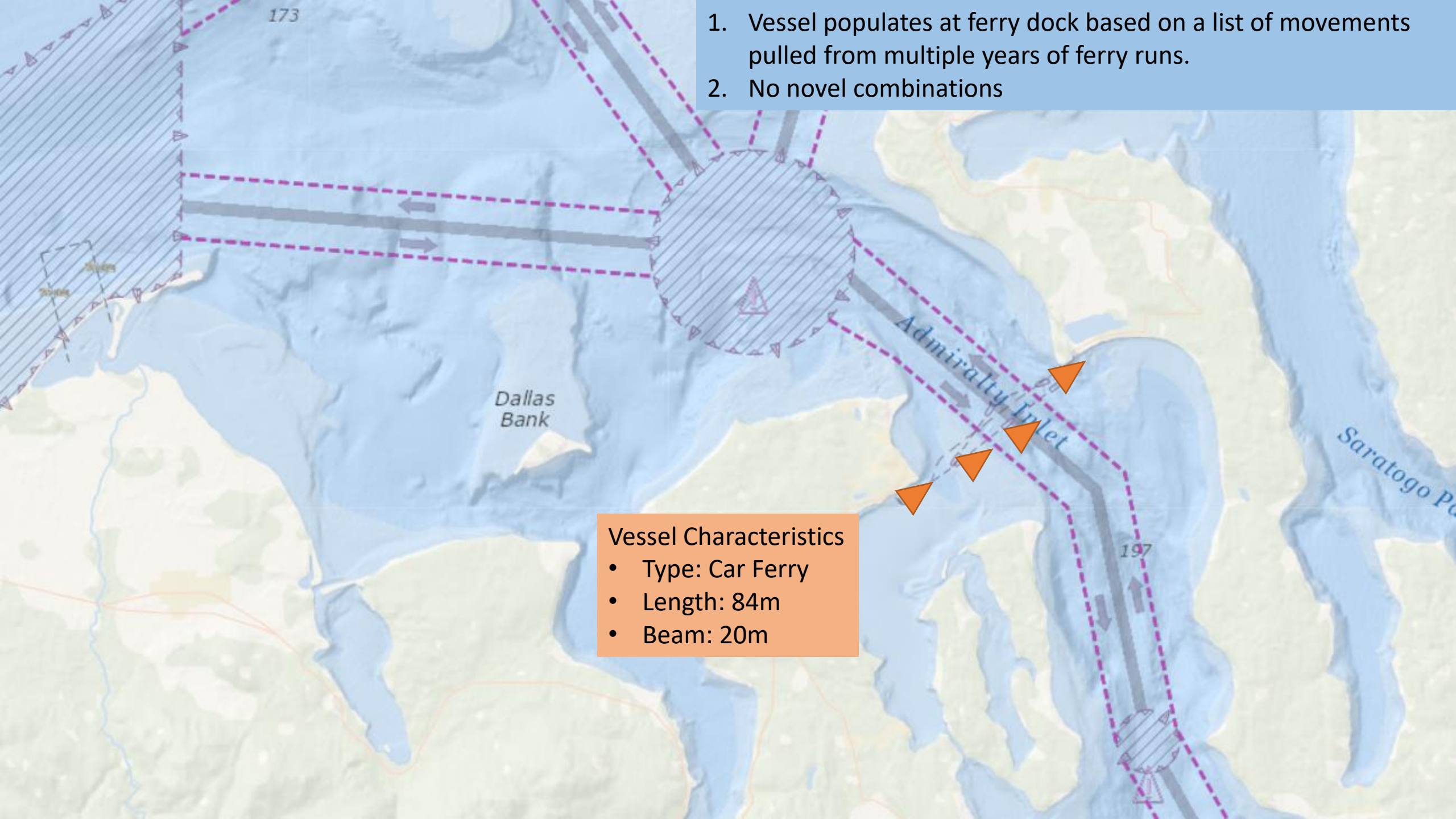

Roberts Bank Facility
12 hours
1. Vessel continues, selecting a route and track at each waypoint
2. At waypoints that precede a “destination,” vessel may anchor/moor
3. When vessel arrives at a berth it determines length of stay from historical data for same vessel type
Bellingham
Lake Whatcom
365



1. When departing the berth, the vessel selects a route
2. Route selection takes into consideration the previous two waypoints
3. This allows vessels to operate on complex multi call journeys, including novel combinations, but grounded in historical patterns


Vessel Movements: Ferries
173
Dallas
Bank
Admiralty Inlet
197
Saratoga Pa

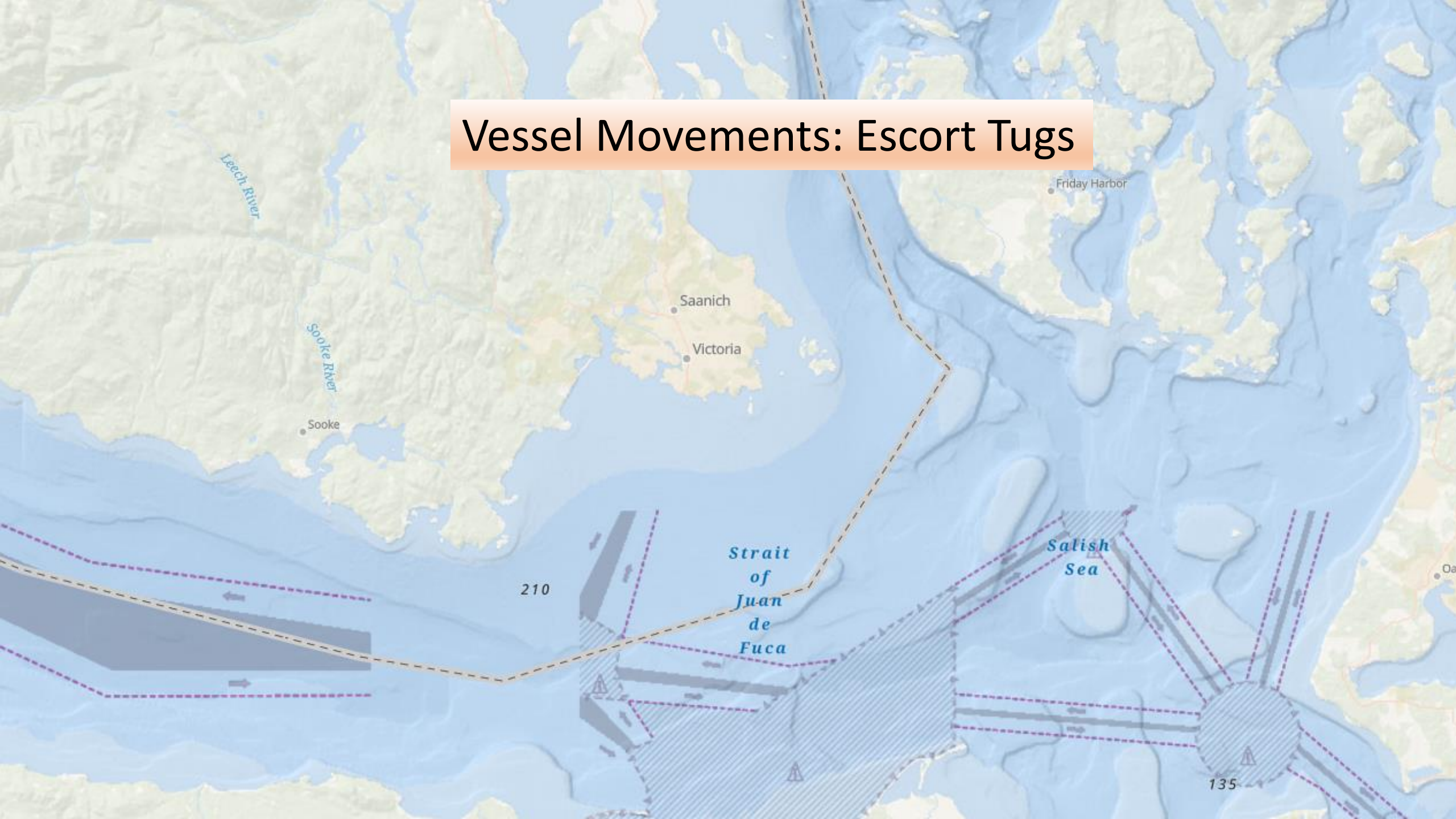
1. Vessel populates at ferry dock based on a list of movements pulled from multiple years of ferry runs.
2. No novel combinations



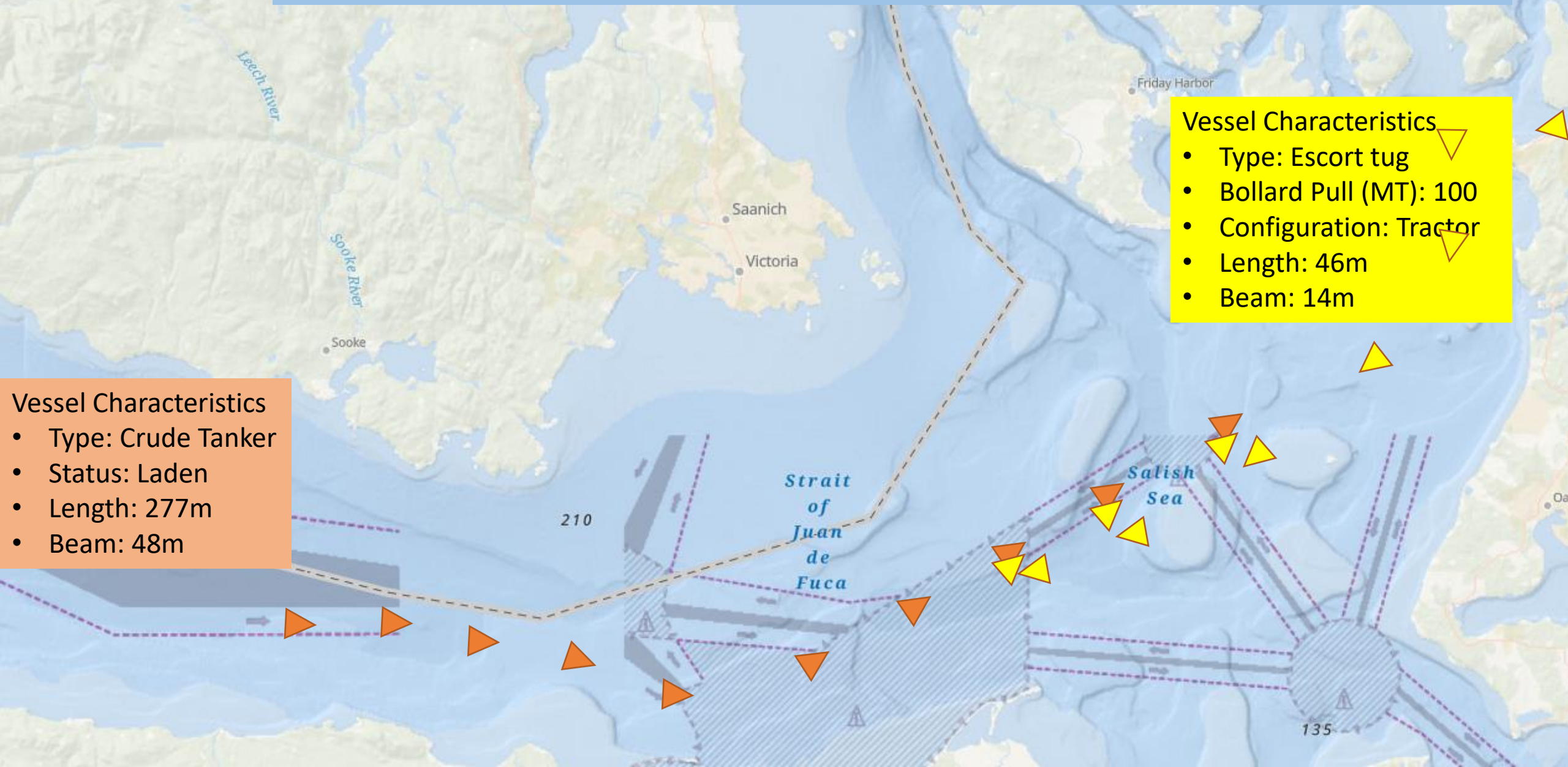
Vessel Characteristics

- Type: Car Ferry
- Length: 84m
- Beam: 20m

Vessel Movements: Escort Tugs

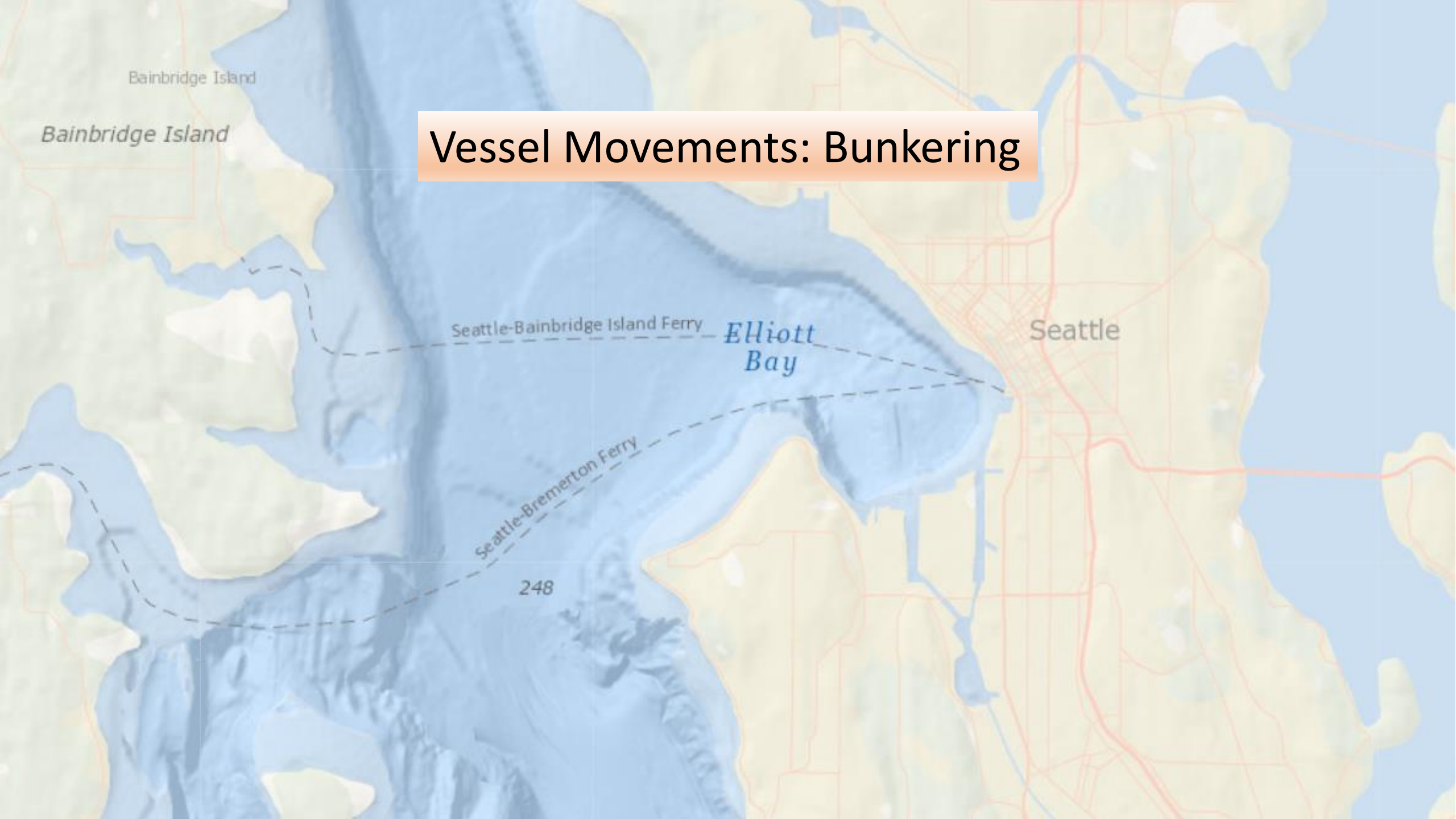


1. When a laden tanker intends to enter escort required area, an escort is populated
2. Populated tug is appropriate bollard pull/configuration for tank vessel
3. Tug is populated in one of a few locations, based on historical origins for vessels providing escorts



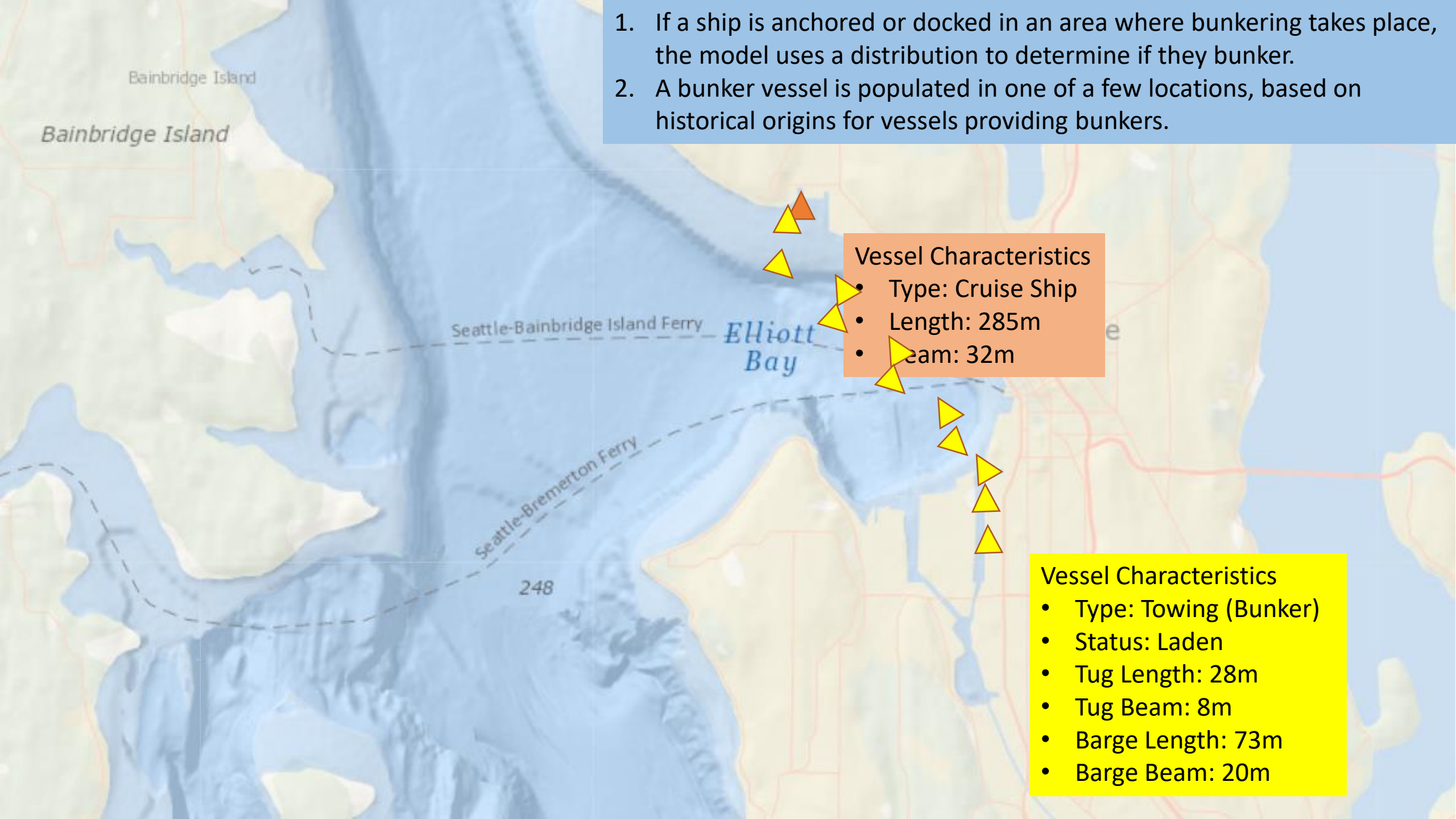
Vessel Characteristics
- Type: Escort tug
- Bollard Pull (MT): 100
- Configuration: Tractor
- Length: 46m
- Beam: 14m

Vessel Characteristics
- Type: Crude Tanker
- Status: Laden
- Length: 277m
- Beam: 48m



Vessel Movements: Bunkering

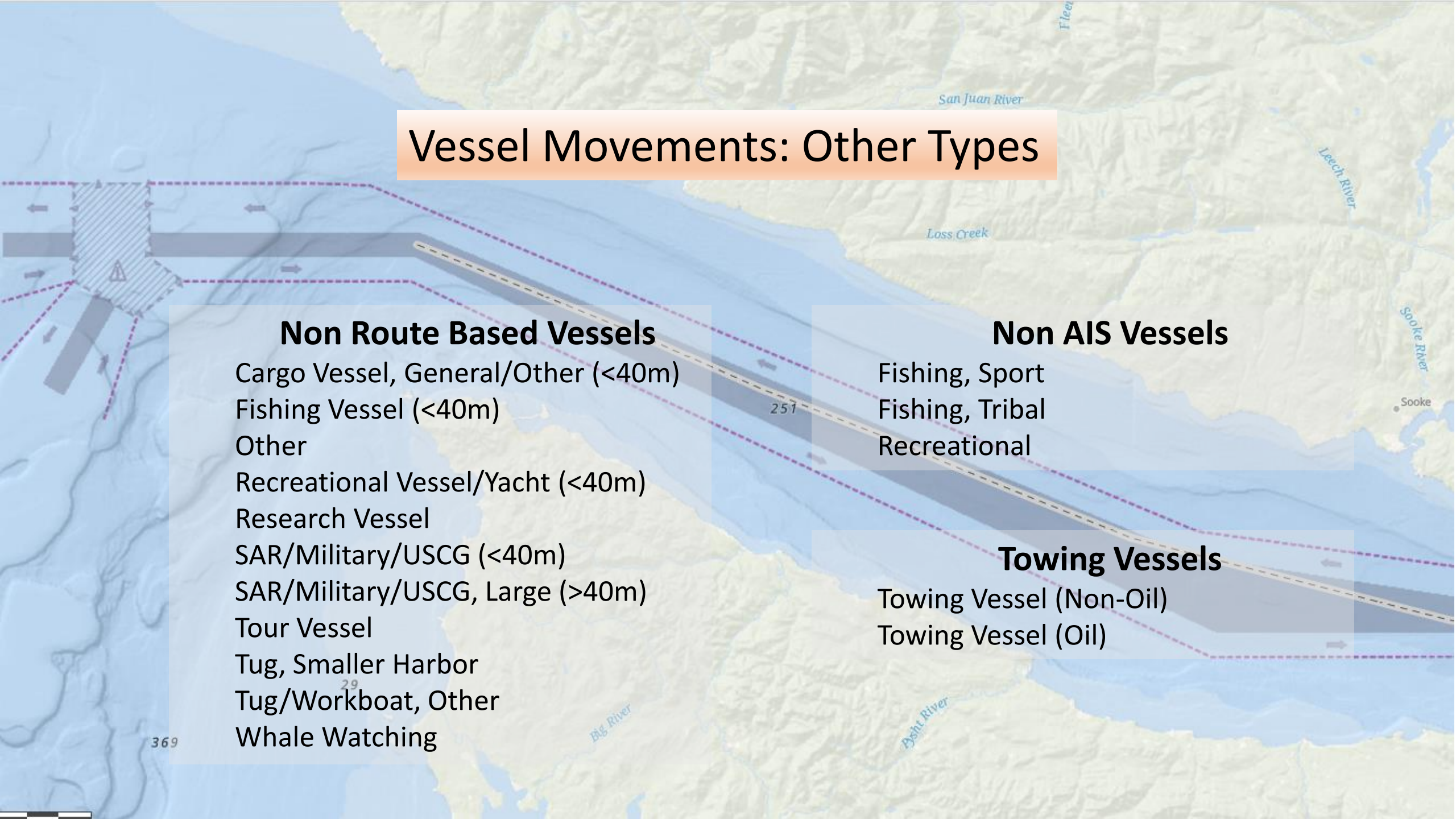
1. If a ship is anchored or docked in an area where bunkering takes place, the model uses a distribution to determine if they bunker.
2. A bunker vessel is populated in one of a few locations, based on historical origins for vessels providing bunkers.



Vessel Characteristics
- Type: Cruise Ship
- Length: 285m
- Beam: 32m

Vessel Characteristics
- Type: Towing (Bunker)
- Status: Laden
- Tug Length: 28m
- Tug Beam: 8m
- Barge Length: 73m
- Barge Beam: 20m

Vessel Movements: Other Types



Non Route Based Vessels

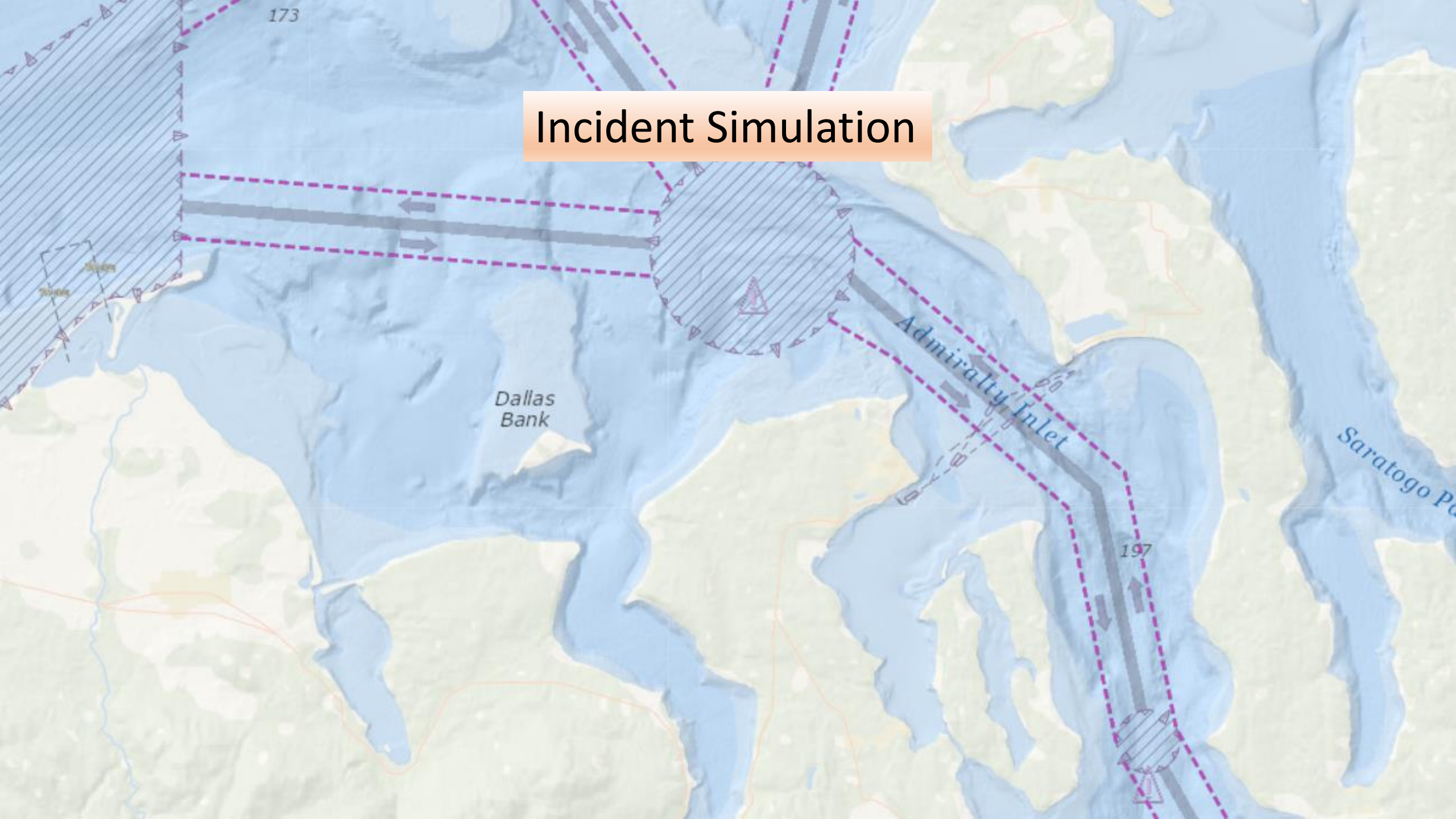
Cargo Vessel, General/Other (<40m)
Fishing Vessel (<40m)
Other
Recreational Vessel/Yacht (<40m)
Research Vessel
SAR/Military/USCG (<40m)
SAR/Military/USCG, Large (>40m)
Tour Vessel
Tug, Smaller Harbor
Tug/Workboat, Other
Whale Watching

Non AIS Vessels

Fishing, Sport
Fishing, Tribal
Recreational

Towing Vessels

Towing Vessel (Non-Oil)
Towing Vessel (Oil)

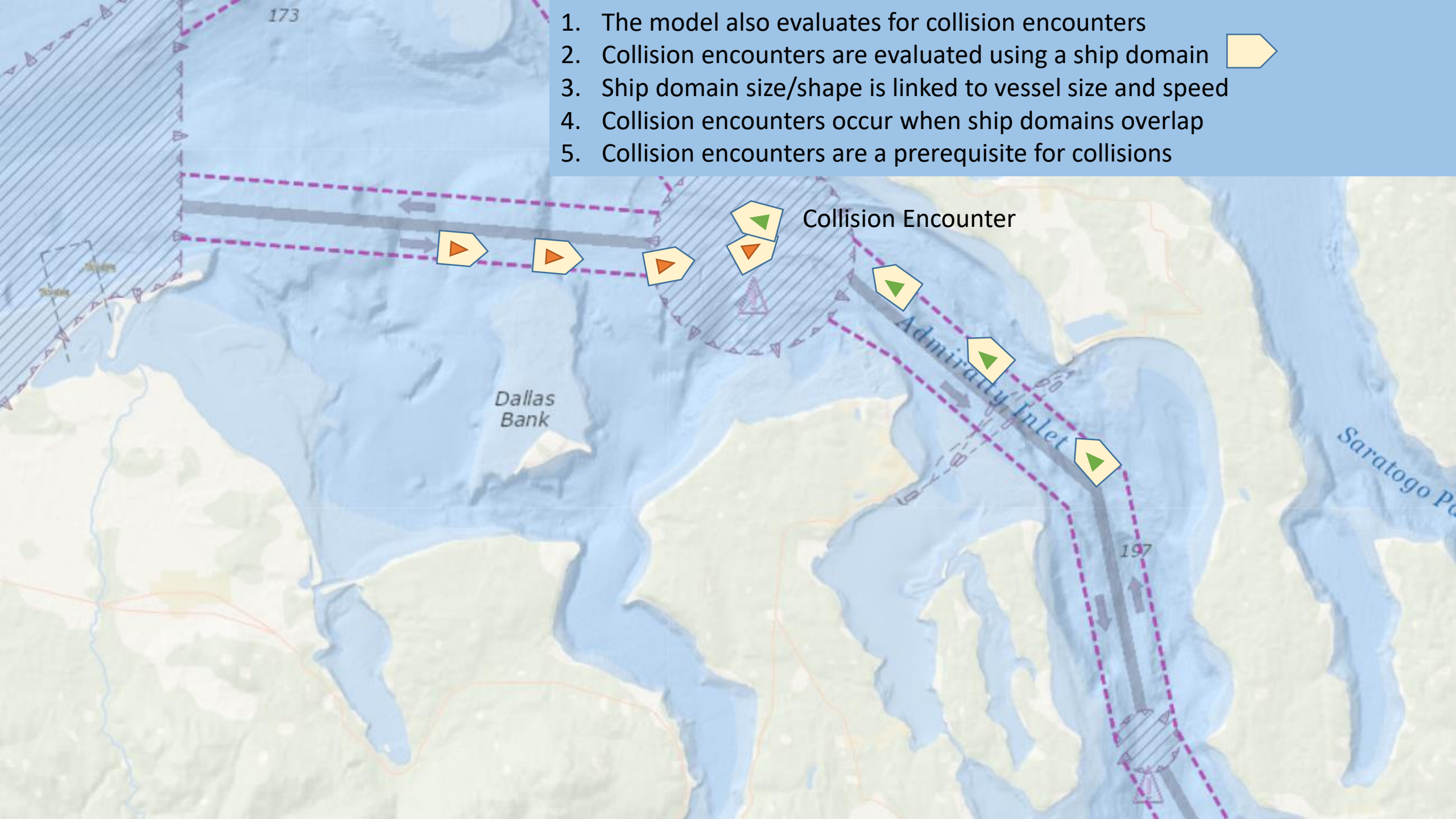

Incident Simulation
173
Dallas
Bank
Admiralty Inlet
197
Saratogo Pa

1. At one minute intervals, the model considers incident potential
2. Including sinking, capsizing, loss of propulsion, etc

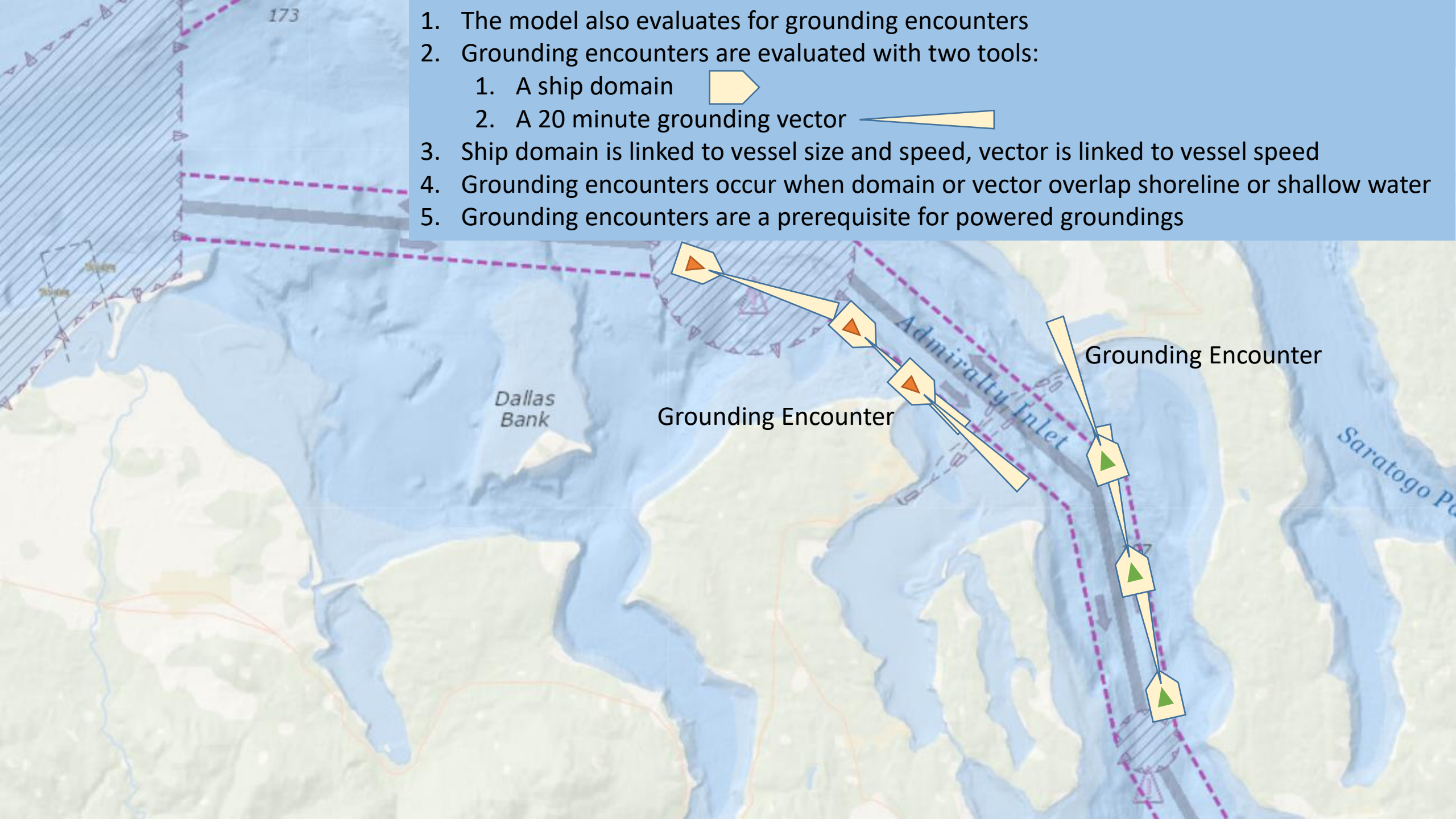
*These are not actual probabilities. They are included as examples only.

hazard	probability	ity	y
Sinking	.00000021/minute*	inute*	nute*
Capsizing	.00000016/minute*	inute*	nute*
Loss of propulsion	.000048/minute*	nute*	ute*

1. The model also evaluates for collision encounters
2. Collision encounters are evaluated using a ship domain
3. Ship domain size/shape is linked to vessel size and speed
4. Collision encounters occur when ship domains overlap
5. Collision encounters are a prerequisite for collisions



1. The model also evaluates for grounding encounters
2. Grounding encounters are evaluated with two tools:
    1. A ship domain
    2. A 20 minute grounding vector
3. Ship domain is linked to vessel size and speed, vector is linked to vessel speed
4. Grounding encounters occur when domain or vector overlap shoreline or shallow water
5. Grounding encounters are a prerequisite for powered groundings



1. For each collision or grounding encounter, the model considers incident potential

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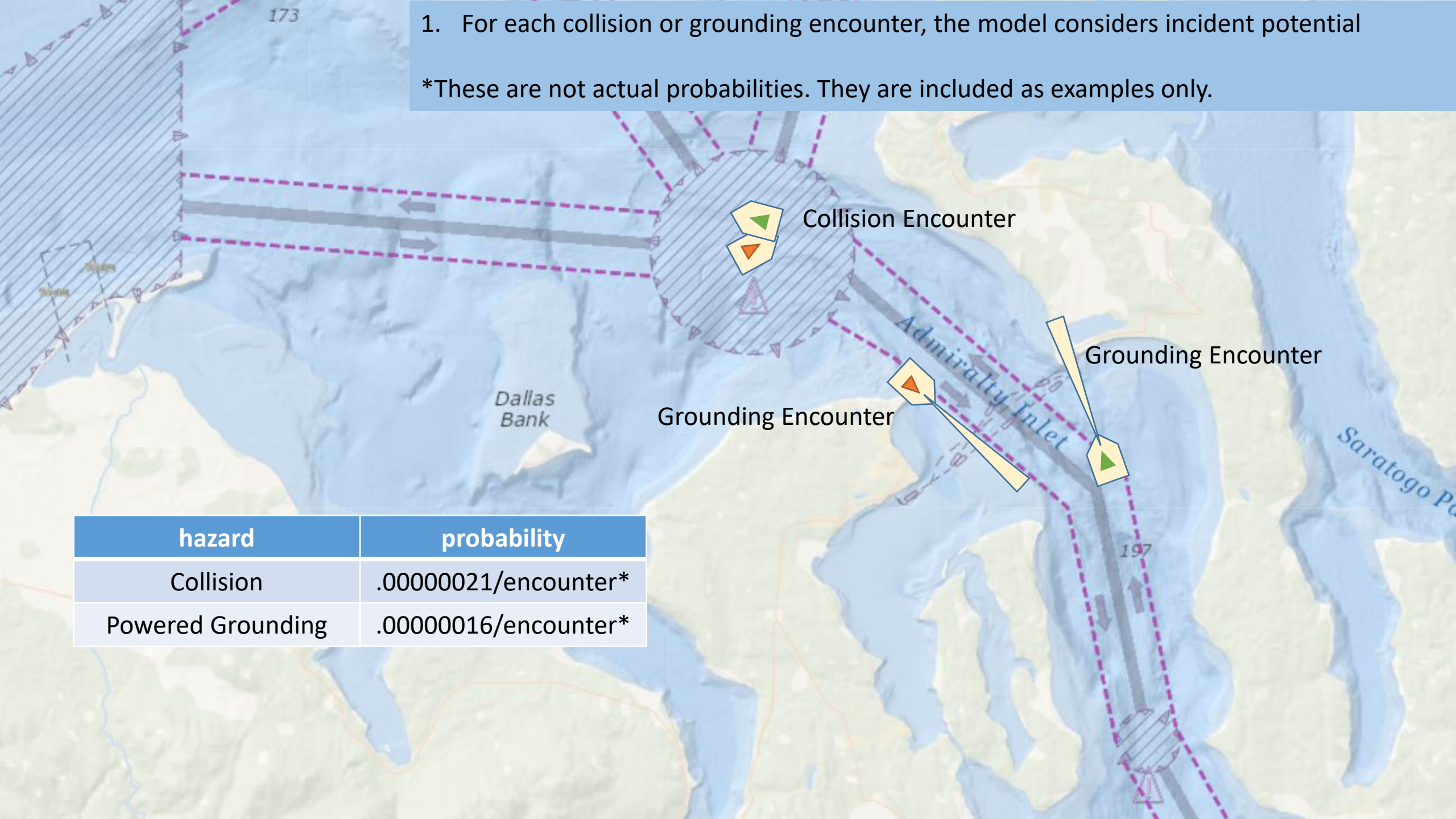


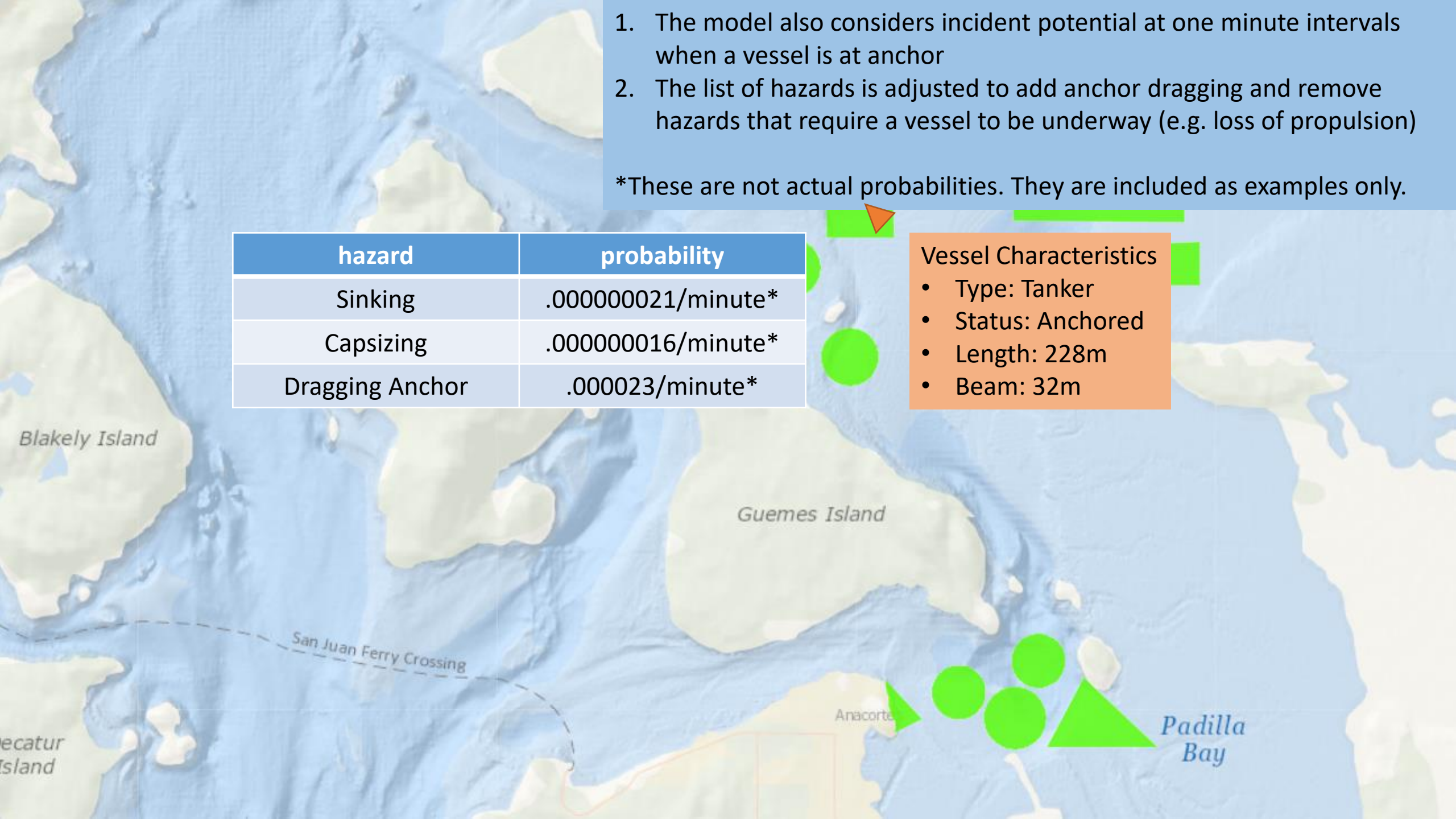
hazard	probability
Collision	.00000021/encounter*
Powered Grounding	.00000016/encounter*

1. The model also considers incident potential at one minute intervals when a vessel is at anchor
2. The list of hazards is adjusted to add anchor dragging and remove hazards that require a vessel to be underway (e.g. loss of propulsion)

*These are not actual probabilities. They are included as examples only.

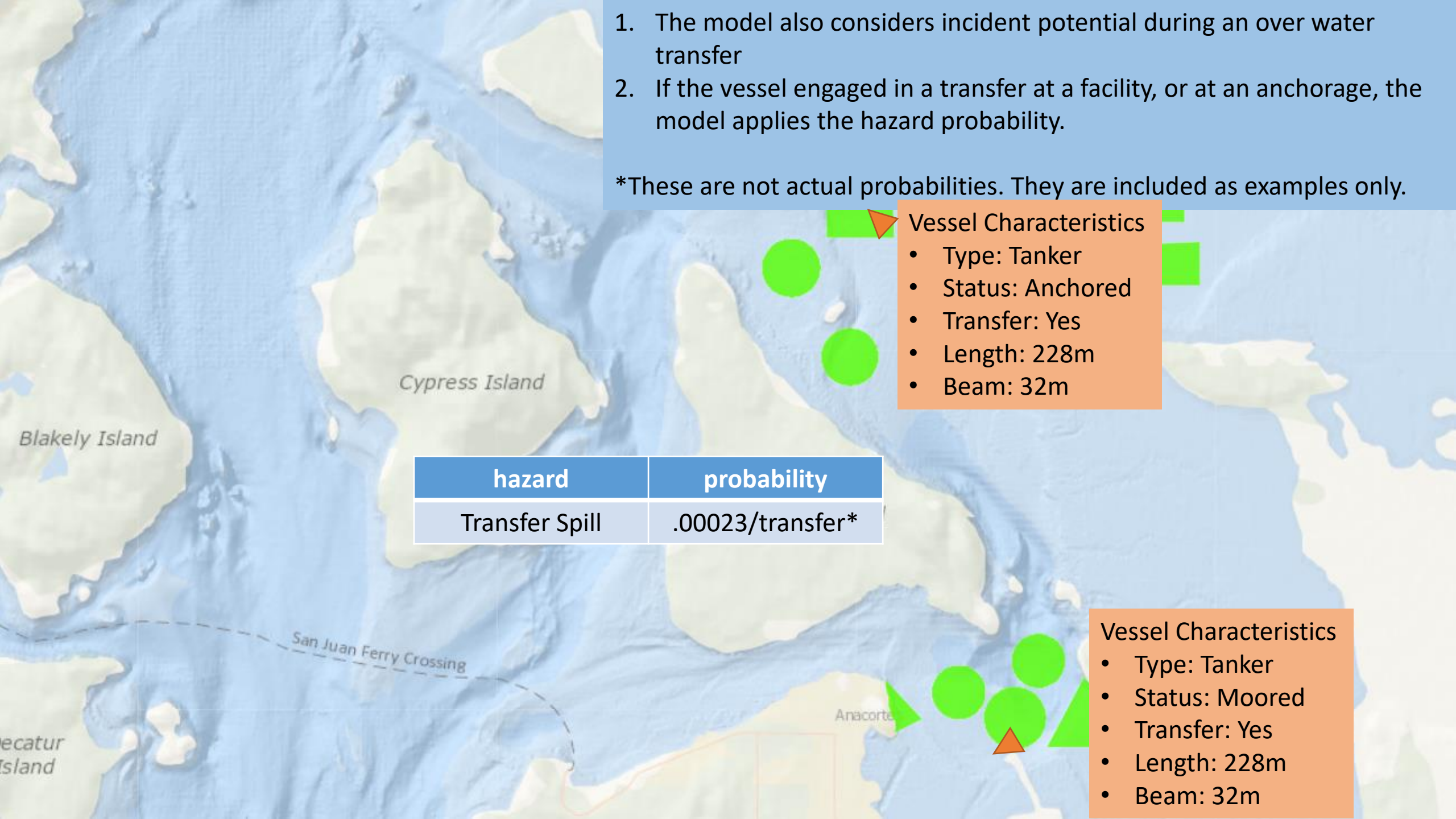
hazard	probability
Sinking	.000000021/minute*
Capsizing	.000000016/minute*
Dragging Anchor	.000023/minute*

Vessel Characteristics
- Type: Tanker
- Status: Anchored
- Length: 228m
- Beam: 32m



1. The model also considers incident potential during an over water transfer
2. If the vessel engaged in a transfer at a facility, or at an anchorage, the model applies the hazard probability.

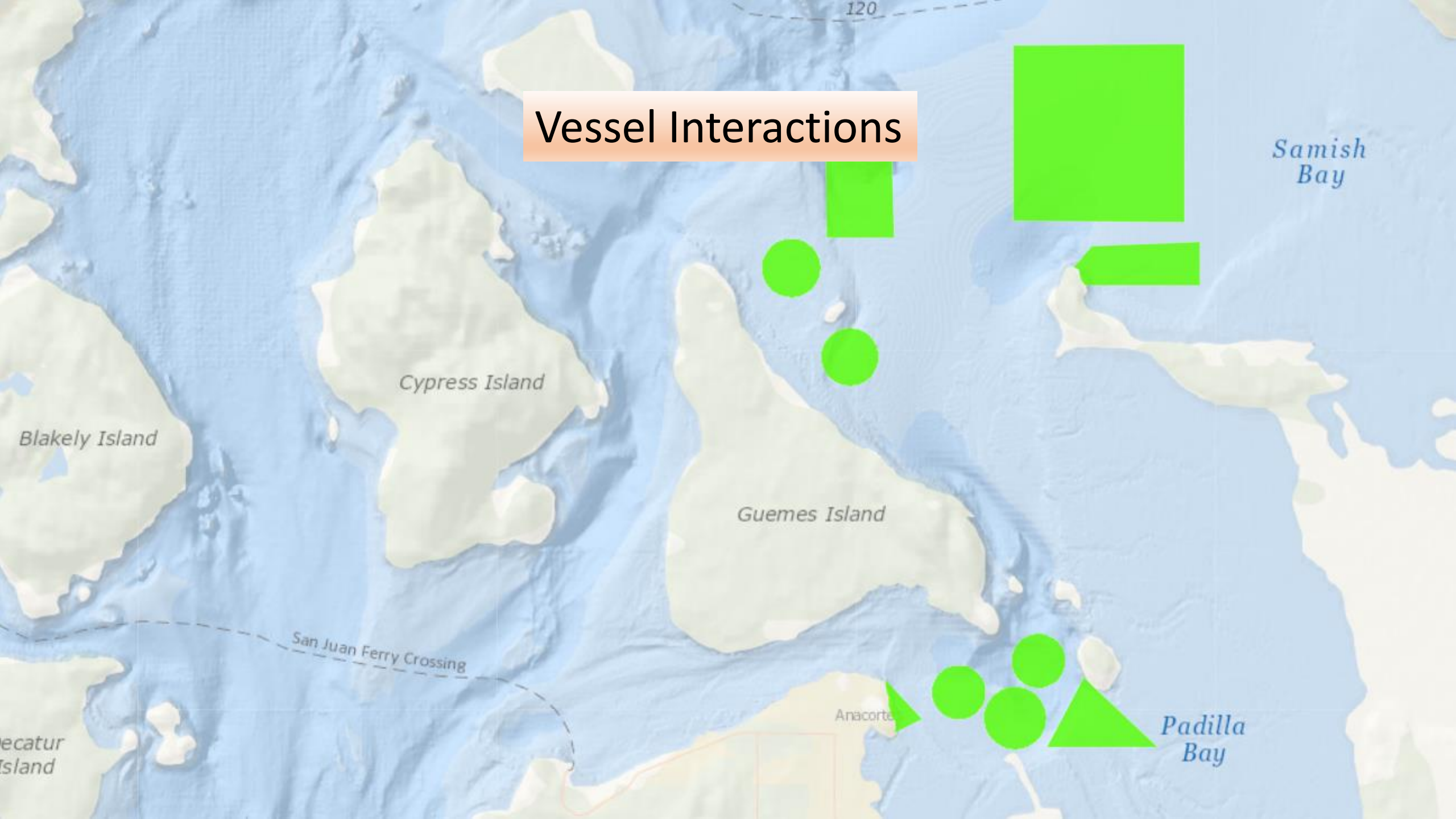
*These are not actual probabilities. They are included as examples only.



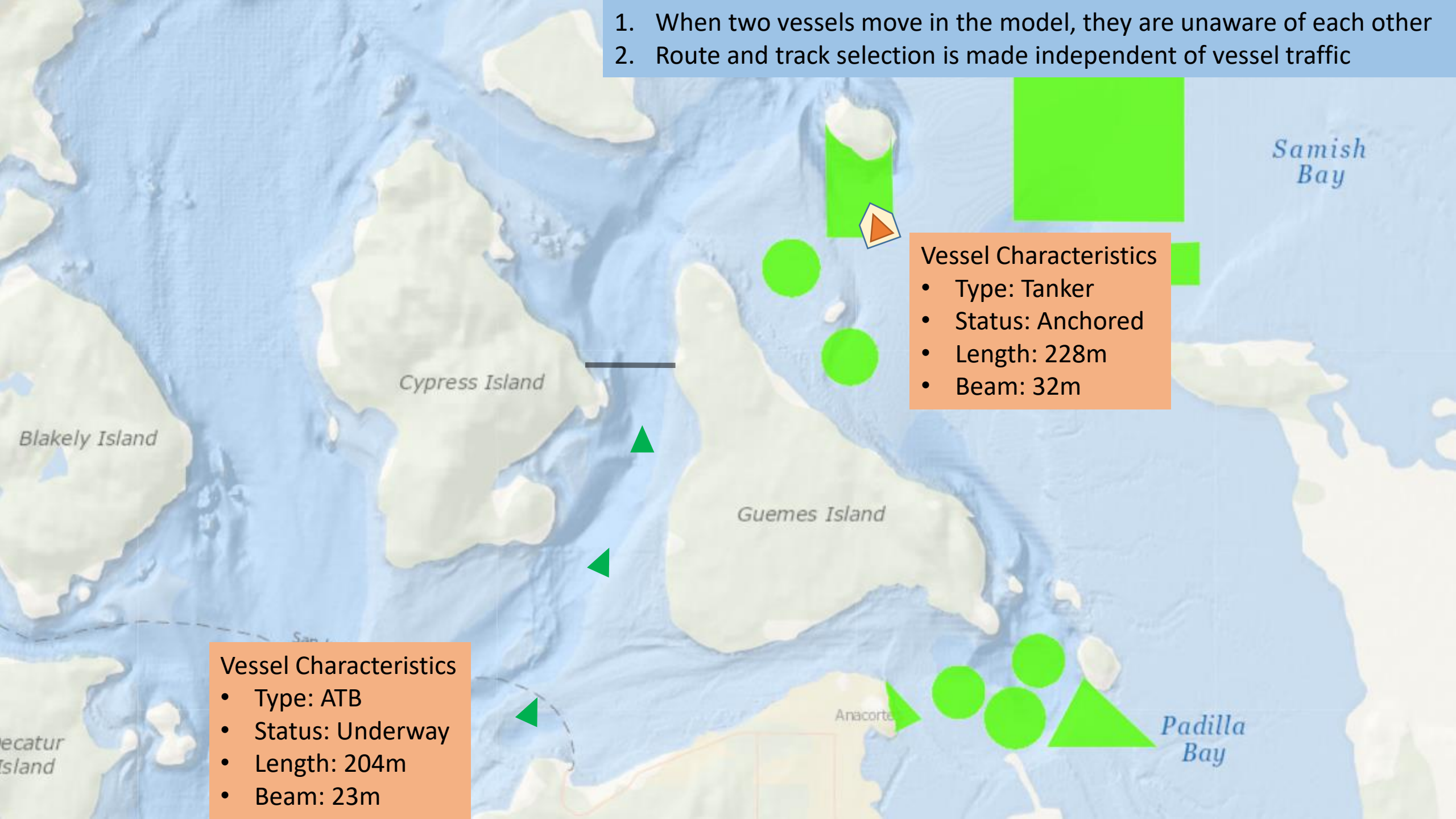
Vessel Characteristics
- Type: Tanker
- Status: Anchored
- Transfer: Yes
- Length: 228m
- Beam: 32m

hazard	probability
Transfer Spill	.00023/transfer*

Vessel Characteristics
- Type: Tanker
- Status: Moored
- Transfer: Yes
- Length: 228m
- Beam: 32m


Vessel Interactions
120
Samish Bay
Cypress Island
Blakely Island
Guemes Island
San Juan Ferry Crossing
Anacortes
Padilla Bay

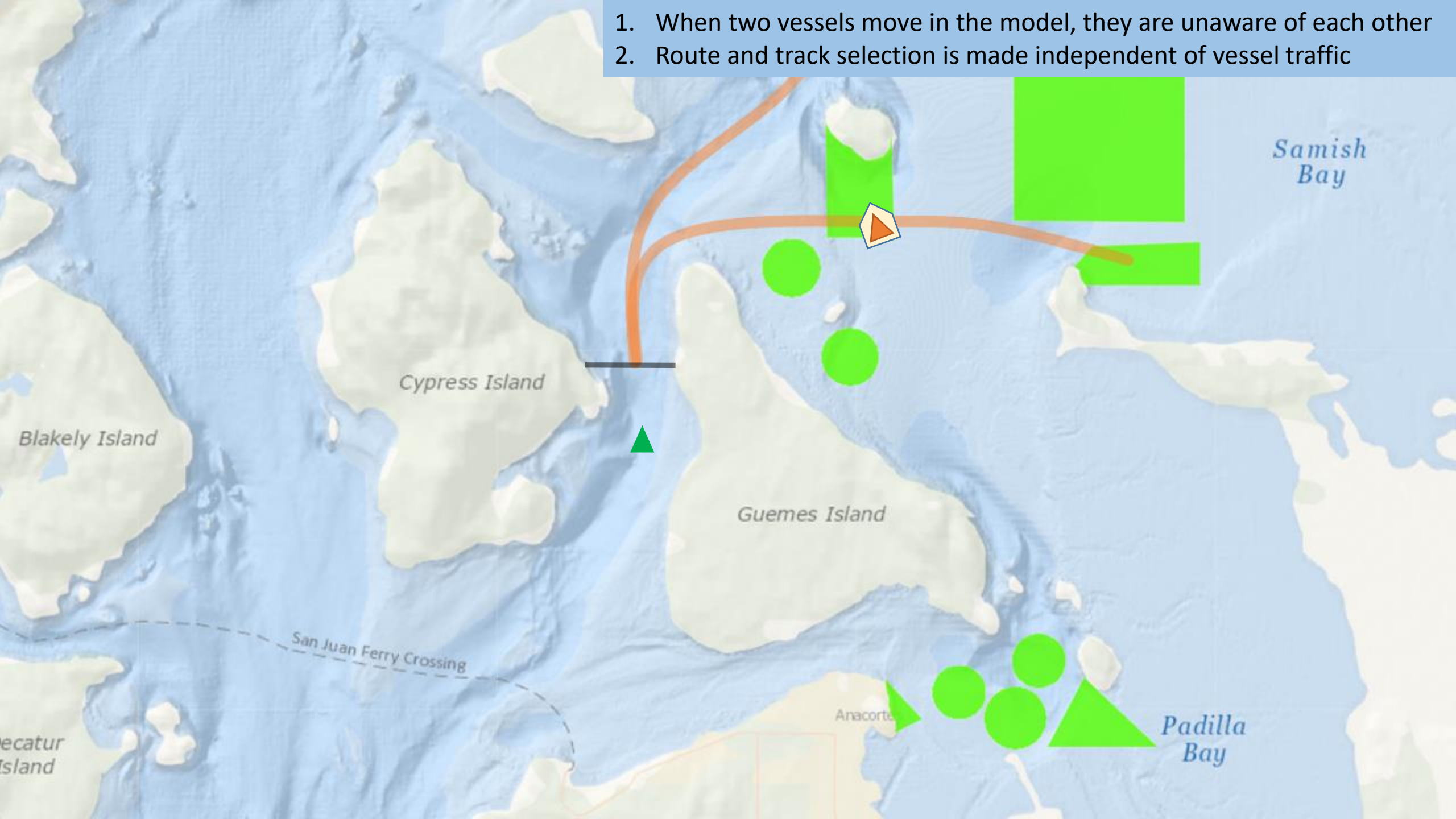
1. When two vessels move in the model, they are unaware of each other
2. Route and track selection is made independent of vessel traffic



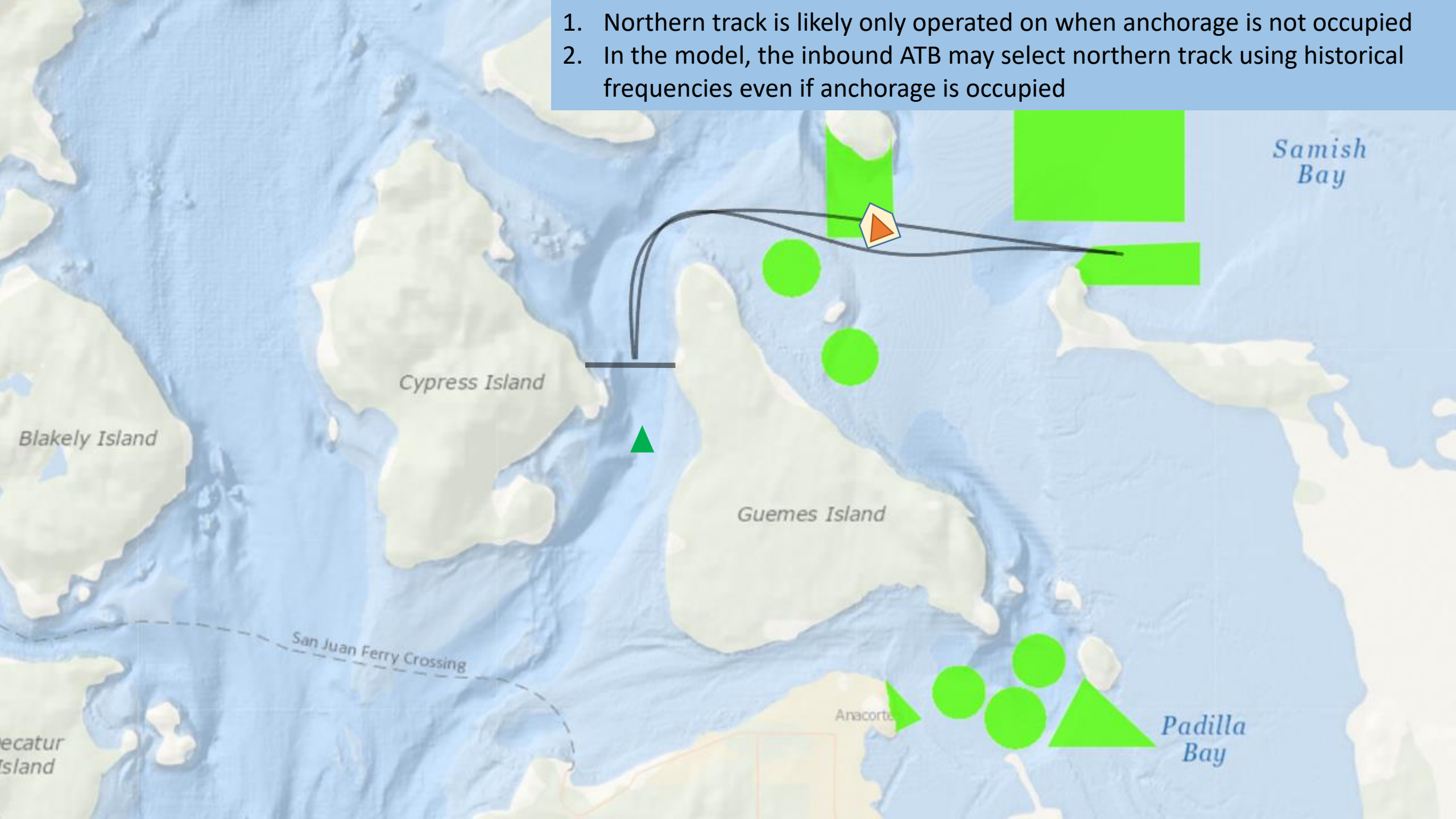
Vessel Characteristics
- Type: Tanker
- Status: Anchored
- Length: 228m
- Beam: 32m

Vessel Characteristics
- Type: ATB
- Status: Underway
- Length: 204m
- Beam: 23m

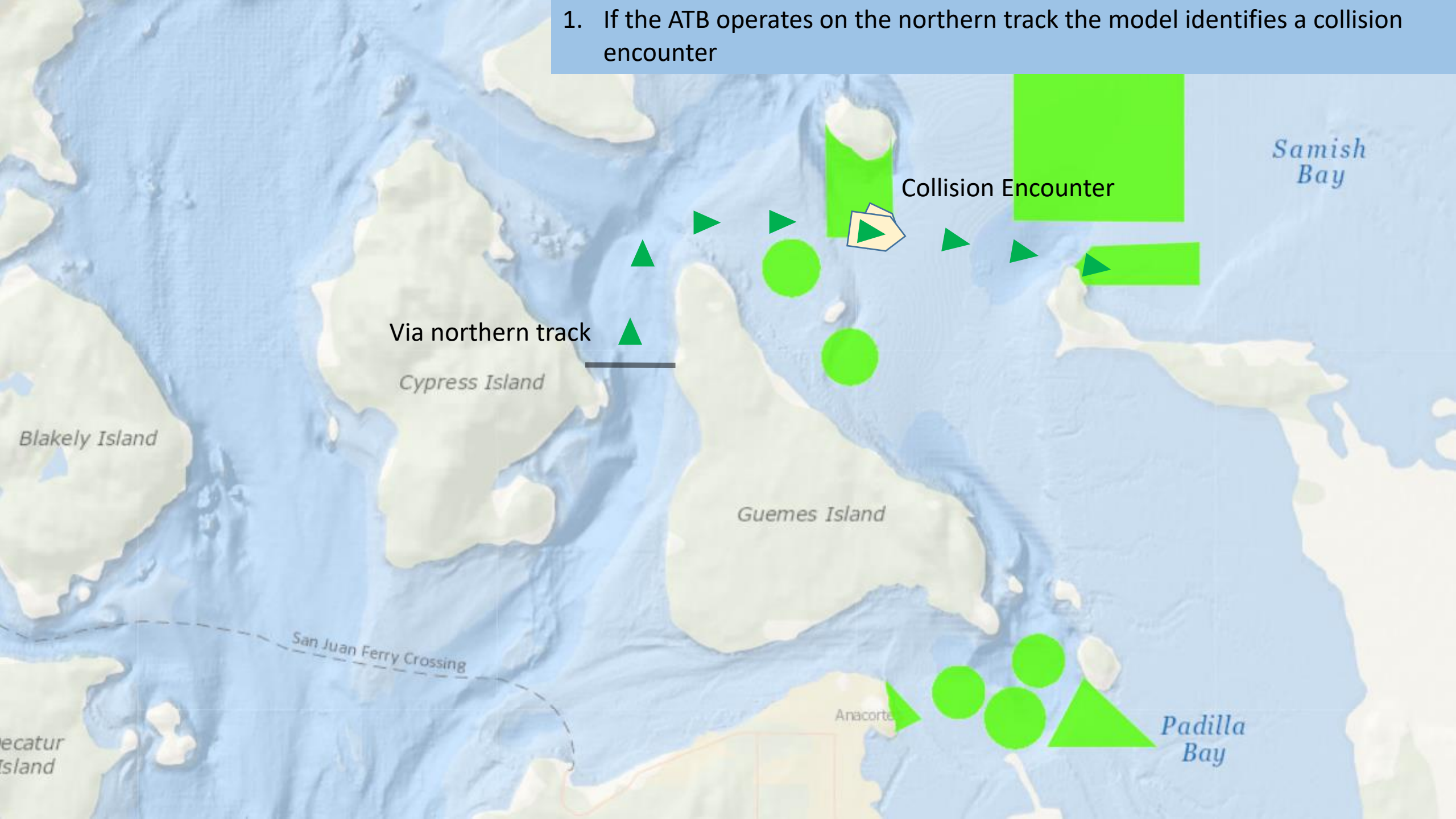
1. When two vessels move in the model, they are unaware of each other
2. Route and track selection is made independent of vessel traffic



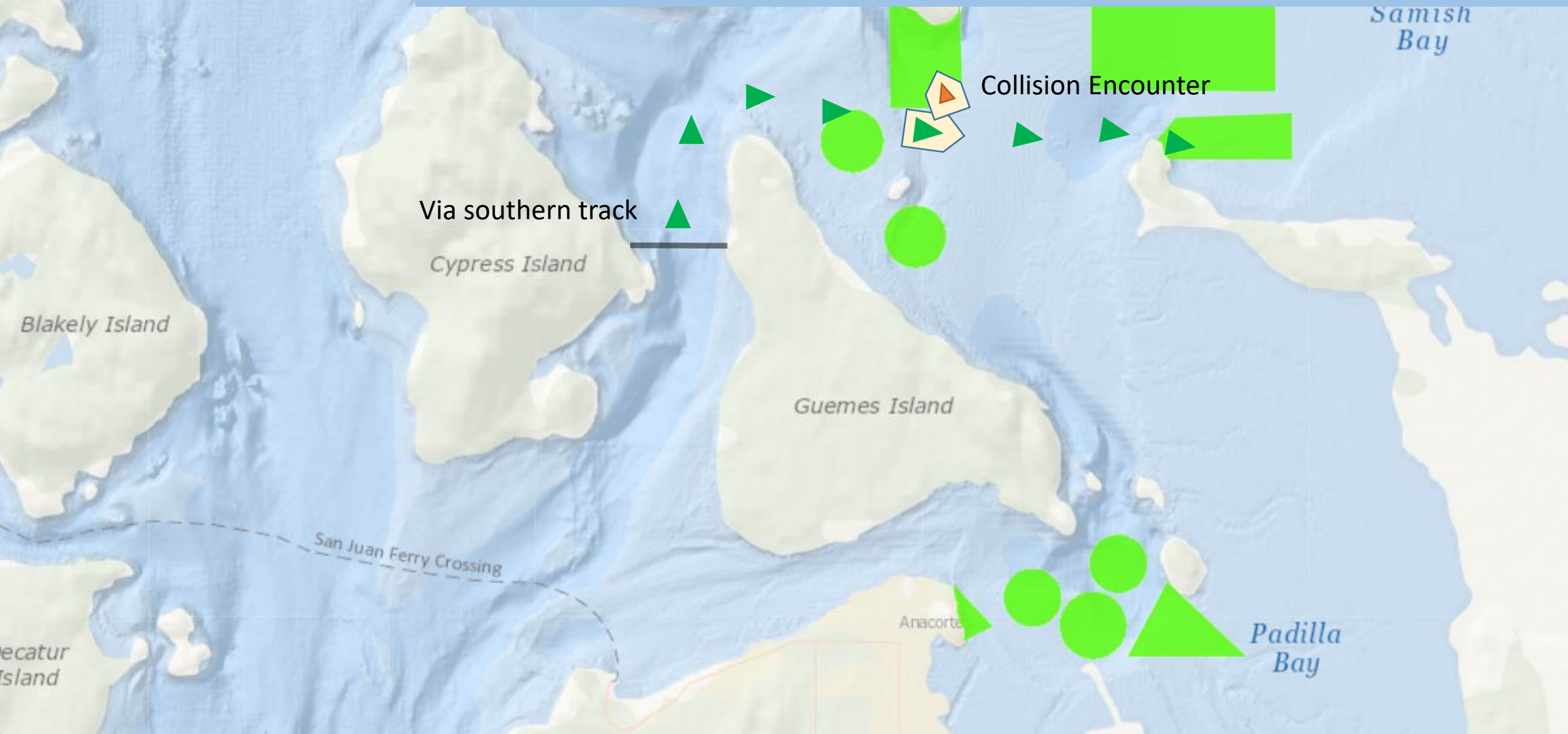
1. Northern track is likely only operated on when anchorage is not occupied
2. In the model, the inbound ATB may select northern track using historical frequencies even if anchorage is occupied



1. If the ATB operates on the northern track the model identifies a collision encounter



1. If the ATB operates on southern track, model identifies collision encounter
2. Ship domains are large enough to find an encounter even if ships are clear of one another
3. Ship domains don't identify "dangerous" situations, just the minimum potential for an interaction to result in a collision



Outstanding Items

Vessel Movement Module

- Remaining vessel types
- Inclusion of navigational rules
- Vessels at anchor: Technical discussion scheduled for July 14th, 2021

Vessel Encounter Module

- Selecting a ship domain

Vessel Characteristics

- Assigning an amount of oil onboard
- Assigning Light or Burdened status to towing vessels

Vessel Accident Module

- Hazard Probabilities: Technical discussion scheduled for July 28th, 2021
- Momentum and Drift Model: Webinar Scheduled for August 18th, 2021

Model 101 In Review

- Ships move between waypoints on historical tracks
- Route selection, anchorage duration, and berth duration selected from distributions
- Dependent vessels like escort tugs, bunkering vessels, and pilot boats are populated only as needed
- Incidents are simulated based on probabilities when prerequisites are met:
  - Must be anchored to have a potential to drag anchor
  - Must be transferring to have a potential for transfer spill
  - Must have collision encounter to have a potential for collision
  - Must have grounding encounter to have a potential for grounding

Contact Info

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Prevention Section

Spill Prevention, Preparedness, and Response Program

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