



Summary report: 2022 Strait of Juan de Fuca voluntary inshore lateral displacement

ECHO Program

Vancouver Fraser Port Authority

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Executive summary

This report summarizes the results of the 2022 voluntary inshore lateral displacement in the Strait of Juan de Fuca (the lateral displacement). The lateral displacement was coordinated by the Vancouver Fraser Port Authority-led Enhancing Cetacean Habitat and Observation (ECHO) Program (the Program), with the input and advice of the ECHO Program's vessel operators committee and advisory working group members.

The Strait of Juan de Fuca is a known area of importance within southern resident killer whale (SRKW) critical habitat that overlaps with commercial shipping lanes. In order to reduce underwater noise – one of the key threats to at-risk whales – in this area, the ECHO Program coordinated its fifth consecutive voluntary lateral displacement for tugs in the Strait of Juan de Fuca between June 1, and October 31, 2022.

While this voluntary measure was in effect, tugboat operators transiting the Canadian inshore area of the Strait of Juan de Fuca were encouraged to laterally displace or move away from the enhanced management area along the southwest coast of Vancouver Island, when it was safe and operationally feasible to do so. Tugs transiting in the outbound lane of the traffic separation scheme were also considered to be participating.

The cumulative participation rate in the lateral displacement was a record-breaking 97%, with 100 of 103 tug transits voluntarily moving away from the enhanced management area. This constitutes a 15% increase from the average participation rate of 82% over the previous three years. This participation rate data was determined using Automatic Identification System (AIS) data provided by the Canadian Coast Guard and analyzed by Transport Canada.

Due to this very high participation rate, a comparative acoustic evaluation between tugs travelling within the enhanced management area, against those in the designated lateral displacement zones could not be conducted. However, previous years of acoustic evaluation indicated the reduction in underwater sound intensity is approximately 4 to 7 decibels (up to 80%) for each participating tug transit.

Marine mammal presence in the Strait of Juan de Fuca and Swifsure Bank areas was monitored by Pacheedaht First Nation through boat surveys within their territorial waters. Between June and October 2022, 71 survey days were completed, with 766 marine mammal sightings made in the combined study area. Of the 71 survey days, there were 24 sightings of killer whales, with SRKW seen on at least seven days.

The record-breaking results of the 2022 Strait of Juan de Fuca lateral displacement further demonstrate that effectiveness of voluntary measures at reducing threats to at-risk whales such as the endangered SRKW.

Overview

Lateral displacement period

June 1 to October 31, 2022

Participation

97% of tug transits

Approximate impact

~4 - 7dB reduction
in underwater sound intensity

1. Background

1.1. The ECHO Program

The ECHO Program is a regional collaborative initiative led by the Vancouver Fraser Port Authority to better understand and reduce the cumulative effects of commercial shipping on at-risk whales off the coasts of British Columbia and Washington State. Since 2014, the ECHO Program has brought together Canadian and U.S. advisors and partners from across government, the marine transportation industry, Indigenous communities, and environmental groups to develop and implement underwater noise reduction initiatives for at-risk whales.

To date, these initiatives have encouraged thousands of ship operators to slow down or stay distanced while traveling within key areas of SRKW critical habitat — helping to measurably reduce underwater noise, one of the key threats to SRKW identified by Canadian and US governments.

In May 2019, the Government of Canada entered into a first-of-its-kind *Species at Risk Act*, [Section 11 conservation agreement](#) with the Vancouver Fraser Port Authority, Pacific Pilotage Authority and five marine transportation industry partners to support the recovery of SRKW. The agreement formalizes the role of the ECHO Program and other conservation agreement signatories to continue working collaboratively over a five-year term to reduce acoustic and physical disturbance from large commercial vessels on SRKW.

In addition to its underwater noise reduction measures, the ECHO Program spearheads world-leading research efforts to broaden understanding of ship-generated underwater noise and inform potential solutions. The ECHO Program has been invited to present its findings to international forums including the International Maritime Organization (IMO) and is recognized as one of the world's most well-known and broadly spanning programs to address underwater noise from ships.

1.2. Context for the voluntary tug lateral displacement

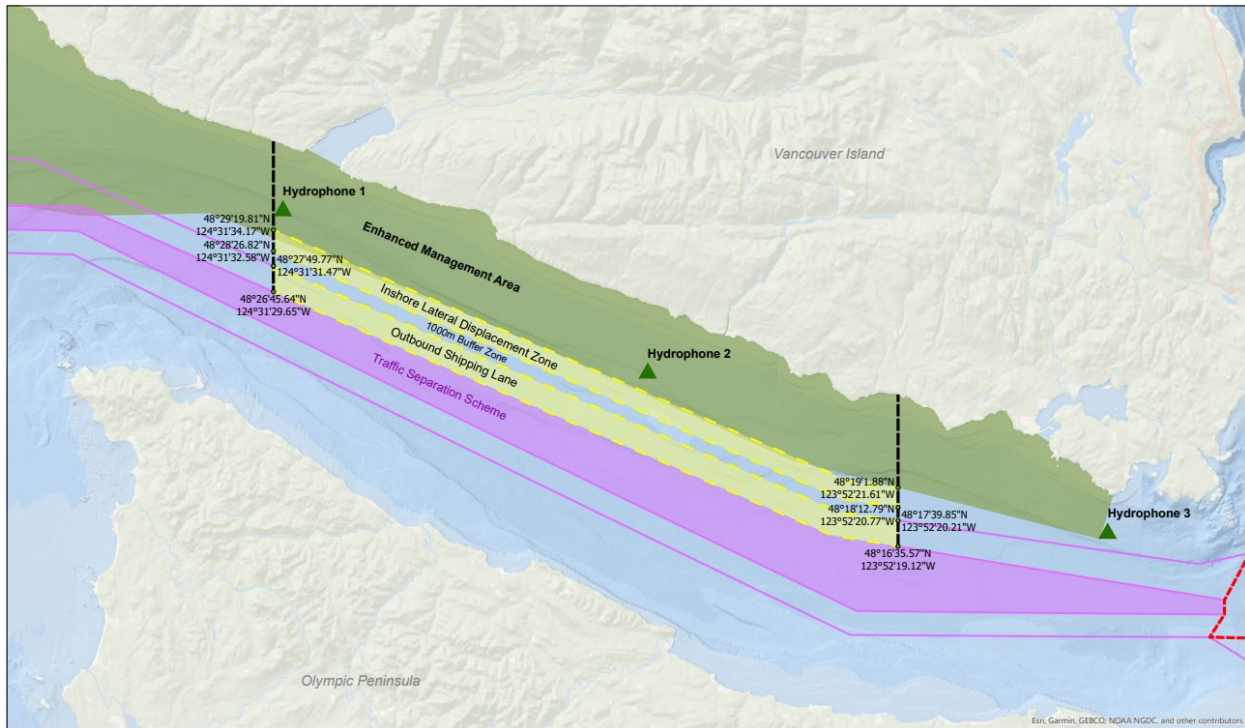
Several at-risk species of cetaceans (whales, dolphins and porpoises) inhabit the Pacific waters of southern B.C. and northern Washington State. Key among these species is the endangered SRKW with a population of only 73 individuals as of July 1, 2022 (Center for Whale Research, 2022). The key threats to SRKW and other at-risk whales in this region include acoustic disturbance (underwater noise), physical disturbance (presence and proximity of vessels), environmental contaminants and availability of prey. Acoustic disturbance related to shipping traffic is a priority focus area for the ECHO Program.

In 2017, the Canadian Science Advisory Secretariat published a science advisory report which identified notable SRKW areas of high use along the northern side of the Strait of Juan de Fuca (Ford et al., 2017). Fisheries and Oceans Canada's recovery strategy (Fisheries and Oceans Canada 2017; 2018; 2022) designates much of the southern British Columbia coastal waters as SRKW critical habitat—the habitat necessary for the survival or recovery of the species. Under the *Endangered Species Act*, critical habitat has also been designated in much of the coastal waters of northern Washington State. Killer whales use sound to navigate, communicate and locate prey via echolocation, and underwater noise generated by vessels can impede these functions.

Previously, under normal operating conditions, inshore tug traffic would often transit through the DFO-defined Enhanced Management Area (Figure 1). Since 2018, the ECHO Program and Transport Canada have coordinated voluntary initiatives—supported by the Canadian and U.S. Coast Guards, Fisheries and Oceans Canada, and the Canadian and U.S. marine transportation industries—to voluntarily shift tug transits southward away from the enhanced management area to reduce underwater noise levels in areas of importance to the SRKW in the Strait of Juan de Fuca.

Building on the findings and success of the initial voluntary lateral displacement trials in 2018 and 2019, and to support ongoing whale recovery measures for SRKW, the ECHO Program has engaged the tug sector and other partners to successfully implement an annual voluntary lateral displacement since 2020.

Figure 1: 2022 voluntary inshore lateral displacement area



Source: Vancouver Fraser Port Authority

1.3. Development of the parameters

A summary of the lateral displacement area, participation instructions and duration are provided in this section. There were no significant changes in parameters to this initiative since 2020.

1.3.1. Lateral displacement area

In the lateral displacement zone and outbound shipping lane (Figure 1), vessel traffic is cooperatively managed by both Canada and the United States. The Cooperative Vessel Traffic Services Agreement (CVTSA) has been in place since 1979 and establishes the structure for the management of vessel traffic in the region. Under this agreement, vessel traffic services in the Strait of Juan de Fuca are provided by the United States Coast Guard in both Canadian and American waters. A joint coordinating group consisting of the Canadian Coast Guard and the United States Coast Guard, which Transport Canada attends, works to ensure safe and efficient transboundary operations. The inshore lateral displacement zone was defined with the support of the joint coordinating group. The majority of the inshore lateral displacement zone is located within the traditional marine territory of the Pacheedaht First Nation.

Since 2020, the inshore lateral displacement zone has been designed to move tug traffic away from the SRKW EMA, while keeping a safe distance from deep-sea vessels transiting in the outbound lane of the traffic separation scheme (Figure 1). The inshore lateral displacement zone is 1,500 metres wide and occurs in the area between 123° 52' W and 124° 31' W, covering approximately 28 nautical miles. As requested by the joint coordinating group, the inshore lateral displacement zone was positioned 1,000 metres north of the traffic separation scheme to provide a safety buffer.

All inshore tug transits were requested to move southward to within the designated inshore lateral displacement zone, while maintaining a 1,000-metre distance from the outbound shipping lane (Figure 1).

Under normal conditions, some tugs transit the Strait of Juan de Fuca in the outbound lane of the traffic separation scheme. As these tugs are already transiting further away from the enhanced management area, these tugs were not requested to change their transit pattern and were deemed as participating if they were transiting in the outbound lane.

1.3.2. Start and end dates

Historical data from Fisheries and Oceans Canada, the B.C. Cetacean Sightings Network and Orca Network indicates that SRKW are most frequently detected in the Strait of Juan de Fuca between June and October. As such, the lateral displacement took place for a five-month duration between June 1 and October 31, 2022.

The start and end of the lateral displacement was communicated to mariners via a Canadian Coast Guard navigational warning (NAVWARN) and a U.S. Coast Guard Notice to Mariners (NOTMAR).

2. Implementation

Implementation of the lateral displacement requires robust coordination and engagement with the ECHO Program's advisors across the marine transportation industry, as well as ongoing monitoring of participation through AIS data analysis. This section details the methods used to coordinate the lateral displacement's launch and monitor voluntary participation throughout its duration.

2.1. Engagement and communications

The ECHO Program coordinated the implementation of this initiative in close collaboration with Transport Canada; the Canadian and U.S. Coast Guards; Fisheries and Oceans Canada; and the Canadian and U.S. marine transportation industries—and, in particular the Council of Marine Carriers and the American Waterways Operators.

The ECHO Program met with the advisory working group seven times in 2022 to share input and advice during the development, implementation, and evaluation phases of the initiative. In addition, the ECHO Program met with the vessel operators committee six times throughout the year to gather input on the lateral displacement's parameters and seek support in monitoring participation. A list of the advisory working group and vessel operators committee members can be found [here](#). The Fraser Basin Council provided independent facilitation services for all ECHO Program advisor meetings

Several communication tools were developed and made publicly available to raise awareness of the lateral displacement, including fact sheets, maps, presentations, and a webpage. In addition to the general distribution of materials by the ECHO Program, the Council of Marine Carriers and the American Waterways Operators supported the distribution of materials and ongoing communication to their members throughout the initiative. Biweekly newsletters were published by the program to its website, as well as separate email communications to associations regarding participation rates.

At the end of the lateral displacement, certificates of appreciation, social media graphics and letters of thanks were provided to each organization that supported, or directly participated in the ECHO Program voluntary initiatives.

2.2. Monitoring

Monitoring of participation was conducted through analysis of AIS data on vessel movements, which was provided by the Canadian Coast Guard and analyzed by Transport Canada. AIS receivers were used to assess the participation of vessels transiting in either the inshore lateral displacement zone or outbound shipping lane during the initiative. The analysis also compared data between lateral displacement years (2018 to 2022) to a 2017 baseline before the initiative was in place.

To better understand the presence and behaviour of whales in the Strait of Juan de Fuca and Swiftsure Bank, the ECHO Program supported Pacheedaht First Nation in undertaking marine mammal observations in both regions between June and October 2022. The full study report is incorporated into the 2022 Swiftsure Bank voluntary vessel slowdown report, available on the ECHO Program website. Marine mammal sightings data in the Strait of Juan de Fuca was also requested from the B.C. Cetacean Sightings Network. The results of these monitoring activities are described in Section 4.2.

3. Tug participation results

Participation of tug traffic in the initiative was evaluated using AIS data provided by the Canadian Coast Guard and analyzed by Transport Canada. A detailed report prepared by Transport Canada (AIS Summary Analysis, June 1 - October 31, 2022) is provided in Appendix A.

To evaluate participation, AIS data was filtered to include vessels transmitting their AIS vessel type as a tug. The data was then amalgamated as vessel tracks and analyzed to evaluate participation using two methods:

- Participation rate: an evaluation of the amount of a tug's transit distance spent in the inshore lateral displacement zone or the outbound shipping lane. Participation was categorized as a tug spending 50% or more of their transit within the inshore lateral displacement zone or outbound shipping lane.
- Distribution analysis: a statistical analysis of the shift in the distribution of tug AIS vessel positions in the inshore lateral displacement zone and outbound lane compared to a 2017 baseline for traffic positions.

Transits near the shore with a total length of less than half of the typical inshore lateral displacement transit length were filtered out of the dataset, after identifying that some tugs were transiting very short distances between two coastal locations (see Figure 2), and as such could not reasonably be expected to use the inshore lateral displacement zone or the outbound shipping lane.

3.1. Participation rates

Participation rates were communicated to tug associations and tug owners and operators by the ECHO Program on a biweekly basis during the lateral displacement. Non-participating tugs were encouraged to participate for future transits. Due to the low number of total tug transits, even a small number of non-participating tugs can impact the overall participation rate.

The cumulative participation rate in the 2022 lateral displacement was 97% (100 of 103) of tug transits that spent more than half of their transit outside of the Enhanced Management Area, either in the inshore lateral displacement zone or outbound shipping lane. This represents a steady increase in participation rates since the onset of this initiative in 2018.

Table 1: Comparison of 2017 baseline tug traffic (without the lateral displacement) against traffic patterns during the 2019 - 2022 lateral displacement

Participation rate for tugs	2017 (baseline)		2019		2020		2021		2022	
	June 17 - Oct 31		June 17 - Oct 31		June 1 - Oct 31					
More than half of transit in the outbound lane or Inshore Displacement Zone (# trips)	52	55%	93	76%	138	82%	126	88%	100	97%
25% to 50% of transit in the outbound lane or Inshore Displacement Zone (# trips)	5	5%	6	5%	11	7%	7	5%	-	-
0% to 25% of transit in the outbound lane or Inshore Displacement Zone (# trips)	12	13%	5	4%	7	4%	0	0%	3	3
0% of transit in the outbound lane or Inshore Displacement Zone (# trips)	26	27%	18	15%	12	7%	10	7%	-	-
Total number of transits in the Strait of Juan de Fuca	95		122		168		143		103	

Source: Transport Canada

Table 2: Summary of tug transit patterns during 2022 lateral displacement

Zone of tug transit (listed north to south)	Number of tugs that spent ≥50% of transit in each zone	Percentage of tugs that spent ≥50% of transit in each zone
Enhanced management area	2	2%
Inshore lateral displacement zone (<i>participation zone</i>)	25	24%
Buffer zone	1	1%
Outbound shipping lane (<i>participation zone</i>)	75	73%
Not in any zone for >50% of transit	-	-
Total number of transits	103	

Source: Transport Canada

Table 2 outlines where tugs were located for the majority of their transit during the 2022 lateral displacement. Overall, 73% (75 of 103) of tugs spent more than half of their time in the outbound shipping lane and 24% (25 of 103) spent more than half of their time in the inshore lateral displacement zone. Tugs that spent more than half of their transit in either of these zones were deemed to be participating.

Figure 2: Total tug transits between June 1 and October 31, 2022 in the initiative area, based on AIS data

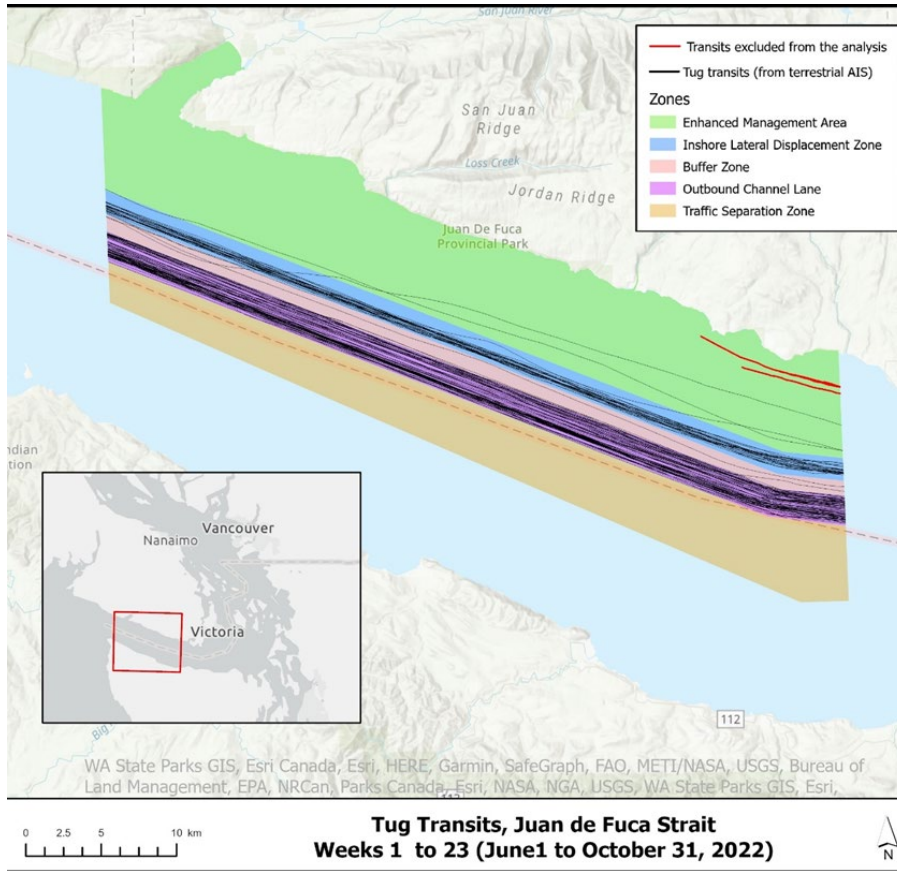
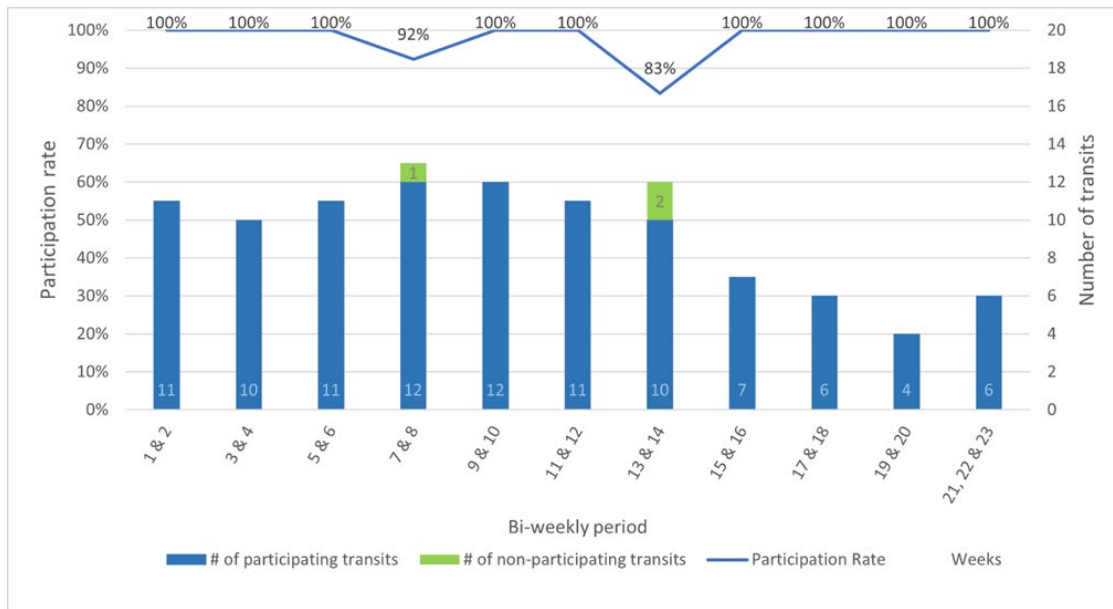


Figure 3: Biweekly participation analysis

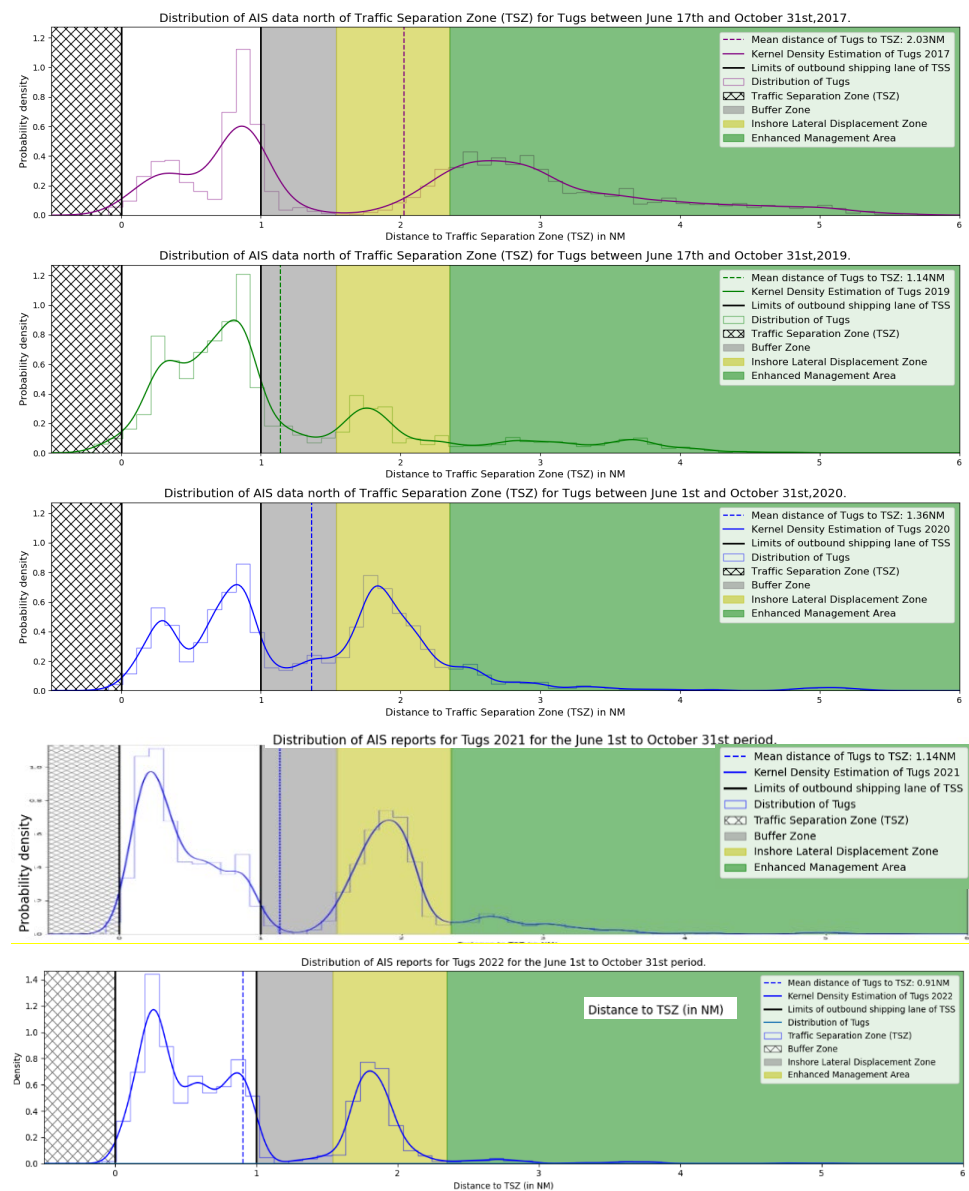


Source: Canadian Coast Guard and Transport Canada

3.2. Tug traffic distribution analysis

In addition to using AIS data analysis to monitor participation, AIS data was used to visualize where tugs transited within the various zones and to compare trends over time, as shown in Figure 4. The data in Figure 4 is displayed as a cross-section of the map in Figure 1, and includes transits completed within the initiative timeline (typically June to October) each year. For 2022 (bottom distribution), the highest density of tug traffic is seen in the two participation zones (white and yellow), reflected by the high participation rate for this year. The 2022 graph also shows an almost-zero traffic density in the buffer zone (cross-hatched area) and enhanced management area (green area) compared to the 2017 baseline. In 2022, tugs showed an average shift of 1.14 nautical miles or 2.1 km southwards, away from the SRKW enhanced management area during the initiative, relative to the 2017 baseline. With each year of the initiative, fewer tugs are transiting in the enhanced management area or buffer zone.

Figure 4: Distribution analysis of tug traffic in 2017 (baseline) compared with 2019 to 2022 (initiative in place)



Source: Canadian Coast Guard and Transport Canada

4. Evaluation and results: acoustics and SRKW presence

A summary of the potential acoustic benefit of the lateral displacement initiative and whale presence observations in the initiative area are discussed in this section.

4.1. Differences in underwater sound levels due to lateral displacement

Previous analysis of underwater sound levels in the Strait of Juan de Fuca resulted in an estimated 4 to 7 dB reduction in underwater sound intensity per tug transit (Vagle 2019, 2020). The results detailed in the 2021 annual report (reference), for just two tugs, indicated an average 4.5 dB reduction in received noise level at the Jordan River hydrophone for a close tug transit versus a displaced tug transit.

As described in previous years, since the inception of the inshore lateral displacement in 2018, there has been a shift in transit routes for tugs away from the Enhanced Management Area to the lateral displacement zone, even outside of the timeframe of the seasonal lateral displacement initiative (June to October). This change in behaviour provides a significant benefit to the SRKW in this area due to reduced noise in the Enhanced Management Area but poses a challenge in the evaluation of tug lateral displacement. There are insufficient acoustic data for tugs transiting close to the Jordan River hydrophone in the Enhanced Management Area to compare against participating tug transits.

Due to these changes in tug traffic, an evaluation of total ambient noise differences between a pre-displacement control period was recommended to not continue past 2021. Acoustic analysis from previous years resulted in an estimated 4 to 7 dB reduction in underwater noise for each tug transit that participated in this initiative.

4.2. SRKW presence in the Strait of Juan de Fuca

During the initiative between June and October, the ECHO Program collaborated with Pacheedaht First Nation to conduct marine mammal observation surveys at Swiftsure Bank and in the Strait of Juan de Fuca. As a result, 71 survey days were completed between June and October 2022, of which SRKW were confirmed on at least seven of the days. Overall, killer whales (transient or SRKW) were seen on 24 survey days. Humpback whales remain as the primary species present across all three survey years. (Hall et al., 2023). The full report of this survey can be found in the Swiftsure Bank ship slowdown report 2023, available on the ECHO Program website.

In addition to these surveys, between June 1 and October 31, 2022, the B.C. Cetacean Sightings Network (BCCSN) received 14 reports of humpback whales and one report of SRKW sightings in the Strait of Juan de Fuca area. Data obtained from the B.C. Cetacean Sightings Network were collected opportunistically with limited knowledge of the temporal or spatial distribution of observer effort. As a result, absence of sightings at any location does not demonstrate absence of cetaceans.

5. Safety and operational results

In preparation for this initiative, safety considerations were discussed by both the Joint Coordinating Group and the ECHO Program vessel operators committee. These discussions informed the development of operational procedures to ensure that the initiative could be executed and managed safely. As a result, no dangerous occurrences or safety incidents were recorded during the initiative period.

The following sections summarize input received from industry participants and Indigenous communities during and after the initiative regarding feasibility and any operational impacts.

5.1. Input from industry

The ECHO Program interviewed a representative from the Council of Marine Carriers following the conclusion of the lateral displacement for 2022. This input, along with general feedback from the ECHO Program vessel operators committee members, indicated that no direct or indirect costs or operational, safety challenges were incurred as a result of the inshore lateral displacement.

6. Key findings and conclusions

Thanks to the contributions of the ECHO Program's many partners and advisors in both Canada and the U.S., the 2022 Strait of Juan de Fuca voluntary lateral displacement successfully reduced underwater noise within a key area for endangered SRKW. Key findings and conclusions of this initiative are summarized below.

Key findings of the 2022 voluntary inshore lateral displacement are:

- 97% of tugs spent over half of their transit in either the inshore lateral displacement zone or the outbound shipping lane, an all-time-high participation rate.
- Tug traffic in the Strait of Juan de Fuca continues to shift away from the DFO-defined Enhanced Management Area, even outside of the lateral displacement time frame, providing additional benefit to SRKW. Because of this, assessment of underwater ambient noise reductions against a pre-displacement baseline is challenging, but based on previous years' data, each participating tug transit is estimated to provide a 4 – 7 dB reduction in received noise level.
- According to data from B.C. Cetacean Sightings Network, there was one report of SRKW and 14 reports of humpback whale sightings in the Strait of Juan de Fuca. Pacheedaht First Nation marine mammal observers completed 71 systematic survey days between June and October 2022 in the Strait of Juan de Fuca and Swiftsure Bank. They observed killer whales on 14 days, and SRKW were sighted on seven of these days.

Overall, the lateral displacement was successfully managed with no dangerous occurrences or incidents recorded. There were no safety or operational concerns recorded with the vessels navigating in the inshore zone during the study period.

The following conclusions are drawn from the 2022 lateral displacement:

- Significant underwater noise reduction can be achieved by laterally displacing tugs away from areas of importance for SRKW, especially at the higher-frequency bands important for foraging, as found in prior years. This shift is being seen even in non-displacement time frames, providing additional benefits to SRKW.
- Continued and additional communications with tug operators who are not affiliated with the Council of Marine Carriers or the American Waterway Operators in advance of and throughout future initiatives will support continued high participation rates.
- With no dangerous occurrences or incidents recorded during the initiative, the 1,000-metre buffer zone is an effective way to manage safety risk.
- Communications about the initiative and collaborations between transboundary partners were effective and resulted in an overall strong participation rate.
- Whale presence data should continue to be collected in future lateral displacement efforts in the Strait of Juan de Fuca to evaluate ongoing SRKW presence and estimate potential benefits of this initiative.

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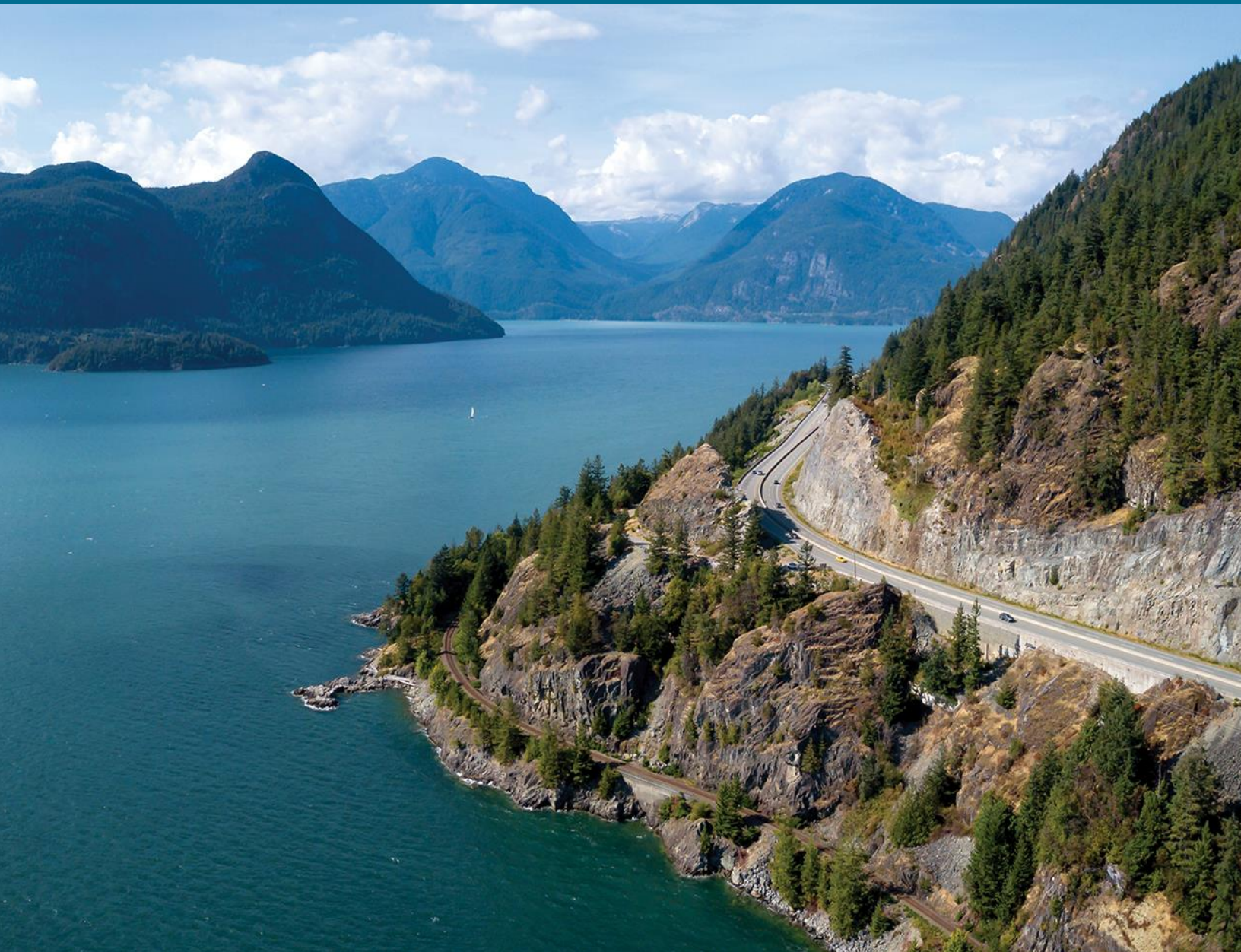


Appendix A

ECHO Program Voluntary Lateral Displacement AIS summary
report 2022

STRAIT OF JUAN DE FUCA LATERAL DISPLACEMENT INITIATIVE 2022: AIS SUMMARY ANALYSIS

June 1 to October 31, 2022



ECHO PROGRAM

2022 Voluntary Inshore Lateral Displacement / AIS Summary Analysis

Acknowledgements

Transport Canada acknowledges the contribution of the Canadian Coast Guard for providing all AIS data, as well as the scripts for data analysis, to ensure consistency throughout the duration of this project.

Abstract

In order to help reduce vessel noise impacts in key Southern Resident killer whale feeding areas, the ECHO Program advanced a voluntary inshore lateral displacement in the Strait of Juan de Fuca to study how moving tug vessels away from known feeding areas affects underwater noise levels in those areas. Several analyses were conducted to assess the impact of this initiative, including this AIS analysis. This document describes the high level of engagement for most of the tug traffic in the area of study.

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I. CONTEXT

The Enhancing Cetacean Habitat and Observation (ECHO) Program is a Vancouver Fraser Port Authority-led initiative aimed at better understanding and managing the impact on shipping activities on at-risk whales throughout the southern coast of British Columbia.

In 2018, the ECHO Program and Transport Canada supported by U.S. Coast Guard, Fisheries and Oceans Canada (DFO), Canadian Coast Guard (CCG), Canadian and U.S. marine transportation industry and Indigenous communities undertook a voluntary trial to study how laterally displacing commercial vessels away from known Southern Resident killer whale (SRKW) feeding areas along the northern side of the Strait of Juan de Fuca would affect the underwater noise levels in those areas. Findings showed that displacing inshore tug and barge traffic resulted in a significant reduction in underwater noise within Southern Resident killer whale foraging habitat.

Since 2019, the ECHO Program has asked tug and barge vessels to participate in the voluntary inshore lateral displacement. The overall purpose of the initiative is to reduce vessel noise impacts in these key SRKW feeding areas.

The 2022 voluntary inshore lateral displacement initiative began on June 1 and ended on October 31, 2022.

During the study, CCG provided Automatic Identification System (AIS) data to Transport Canada to advance the understanding of vessel participation. Transport Canada analysed vessel participation rates and provided bi-weekly summary reports describing traffic patterns to the ECHO Program team. Regular updates on the initiative were released publicly via the ECHO Program newsletter.

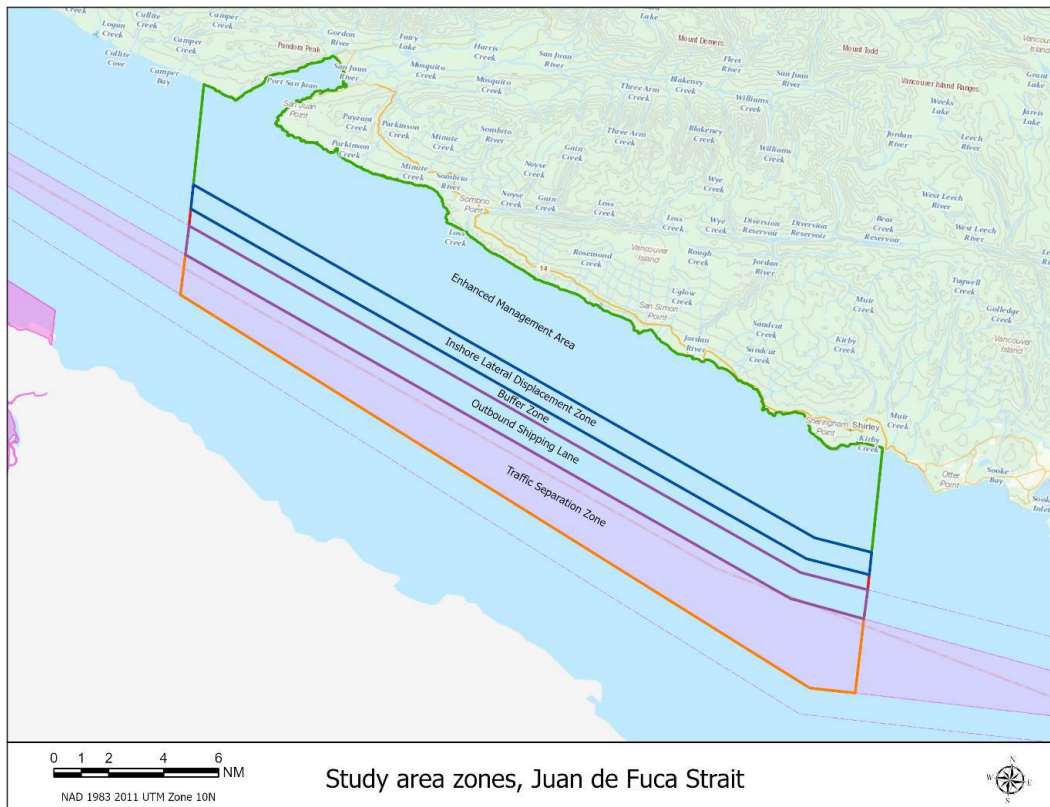
The current document summarizes the analysis based on the terrestrial AIS data collected during the initiative. It aims to illustrate tug participation and changes in traffic pattern in 2022 and provide a comparison to previous years of the lateral displacement initiative.

II. METHODOLOGY

1) STUDY AREA AND TIME FRAME

The study area boundary was restricted to the waters in the Strait of Juan de Fuca, more precisely indicated by the zones defined by the ECHO Program in Figure 1.

Figure 1: Study area zones for the Lateral Displacement Initiative since 2019



The Inshore Lateral Displacement Zone is 1,500 meters wide and occurs in the area between 123° 52' West and 124° 31' West, over approximately 28 nautical miles (NM) (Figure 1). The zone is positioned 1,000 meters north of the Traffic Separation Scheme (TSS) area to provide a safety buffer for vessels transiting the area. An Enhanced Management Area (EMA) was identified by the Government of Canada along the northern side of the Strait of Juan de Fuca as a key foraging area for SRKW (indicated by the green outlined area in Figure 1). During the initiative, tugs were requested to transit either in the outbound shipping lane or between the EMA and the buffer zone within the designated Inshore Lateral Displacement Zone.

The data collection and analysis took place for the duration of the initiative, from June 1 to October 31, 2022, and reporting was completed on a bi-weekly basis.

2) DATA

This analysis is based on CCG Terrestrial AIS data. AIS is a 4-S system (ship-to-shore / ship-to-ship) originally envisioned as a vessel tracking system by Vessel Traffic Services (VTS) and harbour authorities that evolved to improve vessel collision avoidance. In 2004, the International Maritime Organization (IMO) adopted Regulation 19 of the International Convention for the Safety of Life at Sea (SOLAS) Chapter V, “Carriage requirements for shipborne navigational systems and equipment”, which listed mandatory navigational equipment to be carried on board vessels, based on vessel type. This included a new requirement for all vessels to carry Automatic Identification Systems (AIS).

There are two different types of AIS classes. Class A AIS is required aboard all vessels of 300 gross tonnage and upwards engaged on international voyages, cargo vessels of 500 gross tonnage and upwards not engaged on international voyages and all passenger vessels irrespective of size. Class A transponders transmit AIS position reports more frequently: every 2-10 seconds while moving or every 3 minutes when the vessel is at anchor. Class B AIS position reports are sent every 5-30 seconds and every 3 minutes when speed over ground is less than 2 knots. The transmit power of a Class A AIS transponders is also higher than Class B AIS transponders and therefore allows for comparatively better coverage overall.

As in prior years of this analysis, both Class A and Class B AIS messages were used. Class B AIS data is mostly produced by fishing vessels and recreational vessels. Due to the specificities of Class B transponders, a gap in the data was observed near Port Renfrew which limits our ability to represent the traffic accurately for Class B vessels in this area.

3) METHOD

A) FILTERING AND EDITING THE AIS DATA

In order to perform this analysis, AIS data was collected through Canadian Coast Guard Terrestrial AIS infrastructure.

Transport Canada automatically processed the AIS data to identify tug trips based on the Maritime Mobile Service Identity (MMSI) as well as the timestamp for each location. Vessels are assigned to one of 11 different vessel types based on their classification, as transmitted by static AIS messages (type 5 and type 24 messages for Class A and Class B, respectively). However, the classification listed in the AIS messages can contain errors as this information is manually submitted and is therefore prone to human error. To identify tugs from other vessels, the vessel type was verified using Marine Traffic, an external online vessel search service.

In order to only report participation on eligible transits, every transit with a total length less than half of the typical transit length (approximately 28.2 Nautical Miles) have been filtered out in the participation analysis (Sections III)1 and III)2)). This measure was taken after identifying that some transits were very short distances between two coastal locations, thus could not reasonably be expected to use the inshore lateral displacement zone or the outbound shipping lane.

Between 2018 and 2020, CCG undertook the data analysis for vessel participation including data used as the baseline, between June 17 and October 31, 2017. Findings are detailed under Section 3 of this report on tug trend analysis.

Transport Canada undertook the data analysis for June 1 to October 31 in 2021 and 2022. Since baseline data from 2017 and previous years participation data was unavailable to repeat the comparative analysis, a modified comparison was conducted using graphics previously provided by CCG (Figure 5).

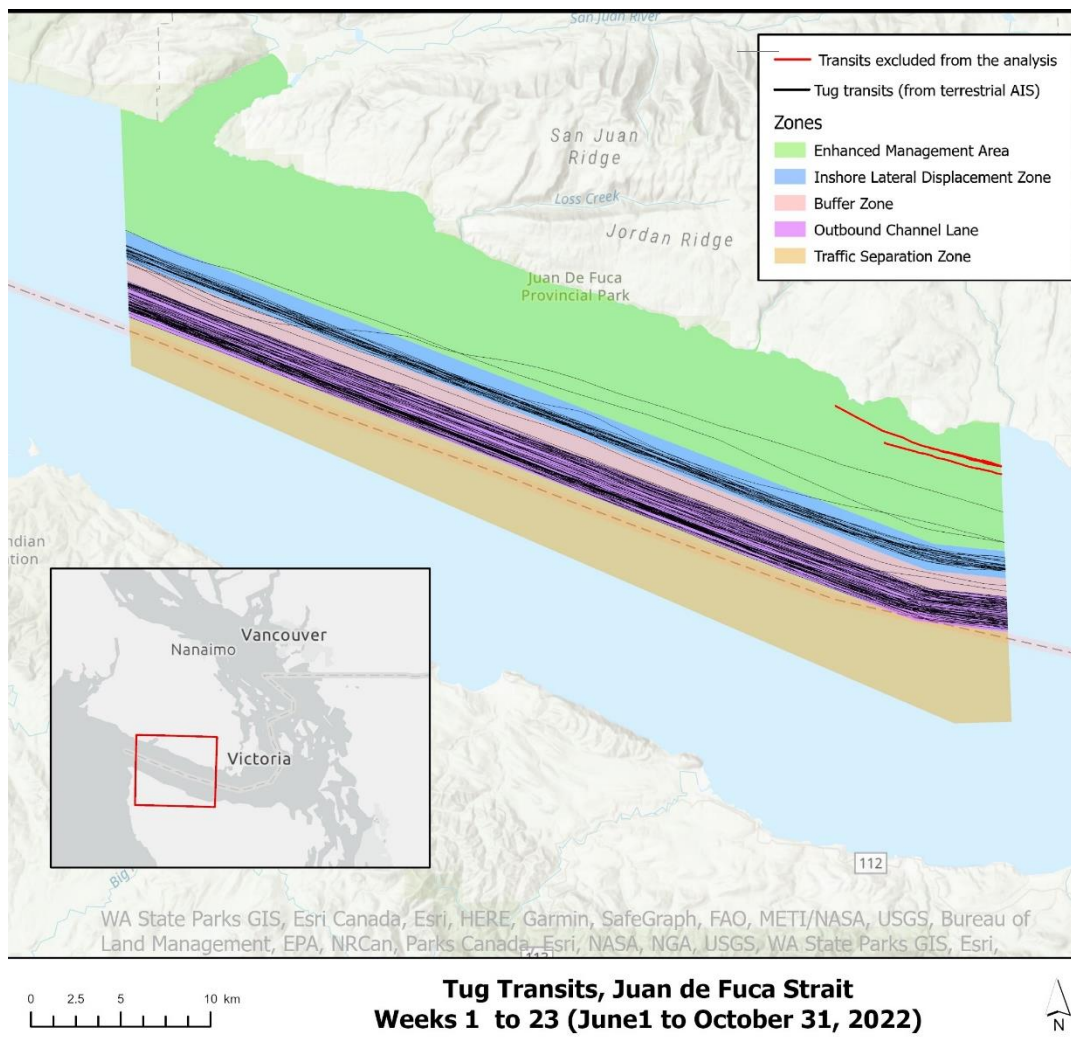
B) INDICATORS

Indicators were measured for each vessel trip using spatial analysis. These indicators were used to automatically identify whether the trip was to be considered for the analysis or not. This also allowed the quantification of the ratio of each transit within the different zones.

In 2019 through 2022, tug vessels were asked to transit within the outbound lane of the Traffic Separation Scheme (TSS) or inshore lateral displacement zone (See Figure 1). The 1000m zone in-between named “Buffer Zone” was intended to act as a separator between inshore traffic and outbound lane traffic.

Figure 2 represents all the tug transits based on Terrestrial AIS data that were used for this analysis of the 2022 initiative. The transits filtered out of the analysis as mentioned in the last sub-section II)3)a) are represented in red, while all the other transits are represented in black.

Figure 2: All tug transits during the lateral displacement period in 2022

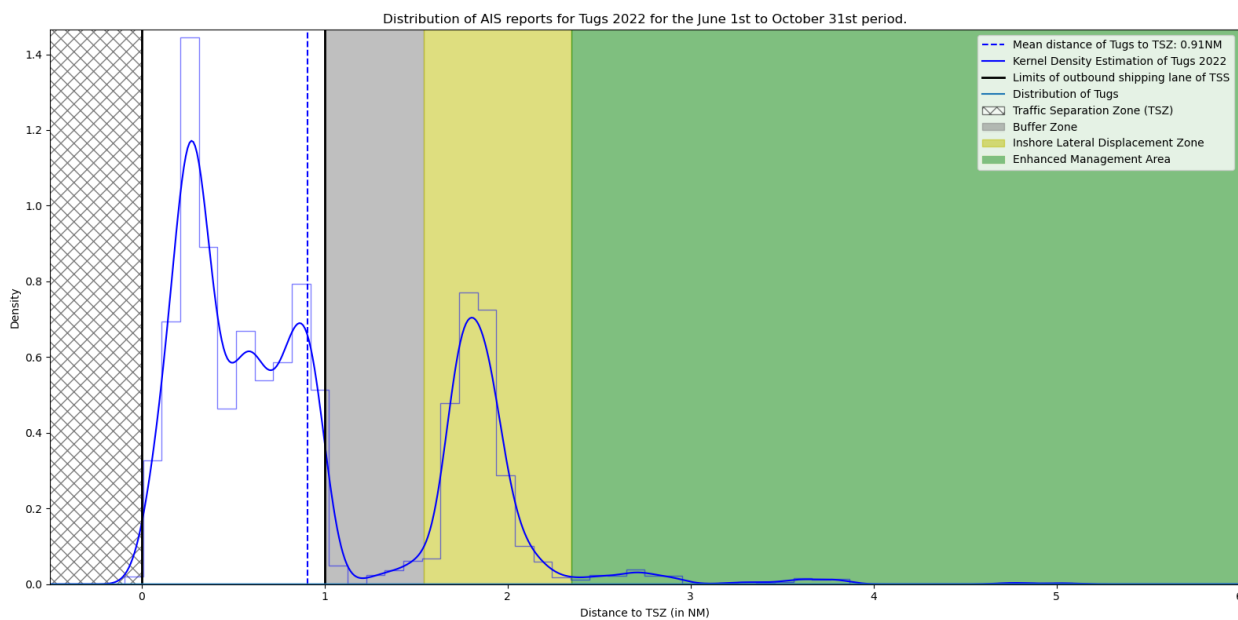


C) DISTRIBUTION ANALYSIS

In order to confirm and better quantify the shift in tug traffic in the Strait of Juan de Fuca due to the initiative, a distribution analysis was undertaken on the reported AIS positions in the study area.

Figure 3 illustrates the probability density (measured as the number of AIS position reports divided by the total number of observations multiplied by the bin width) of the position reports received by tugs navigating in the zone during the 2022 initiative on the Y-axis, and the distance to the TSZ in nautical miles for the X-axis. The integral under the histogram and the Kernel Density Estimation are both equal to one.

Figure 3 Distribution analysis (2022 tug vessel transit positions, as a cross section of the zones shown in Figure 2)



III. TUG TRAFFIC ANALYSIS

1) OVERALL PARTICIPATION

One hundred and three (103) tug transits were observed in the study area between June 1 and October 31, 2022. Table 1 outlines the baseline and participation rates between 2018 and 2022 for the lateral displacement initiatives.

Table 1: Tugs lateral displacement achieving rates 2018 – 2022 with baseline tug behaviour in 2017

Achieving rate for tugs	2017* (baseline, no displacement)		2018*		2019*		2020		2021		2022	
	June 17 - Oct 31, 2017		August 20 - Oct 31, 2018		June 17 - Oct 31, 2019		June 1 - Oct 31, 2020		June 1 - Oct 31, 2021		June 1 - Oct 31, 2022	
# Trips ≥50% in the outbound lane and Inshore Displacement Zone	52	55%	61	80%	93	126	88%	76%	138	82%	100	97%
# Trips ≥25%-<50% in the outbound lane and Inshore Displacement Zone	5	5%	2	3%	6	7	5%	5%	11	7%	0	0%
# Trips >0%-<25% in the outbound lane and Inshore Displacement Zone	12	13%	4	5%	5	0	0%	4%	7	4%	3	3%
# Trips 0% in the outbound lane and Inshore Displacement Zone	26	27%	9	12%	18	10	7%	15%	12	7%	0	0%
Total # of Tug Trips in the Canadian Strait of Juan de Fuca	95		76		122		168		143		103	

**In 2018, the first year of the trial, tugs were asked to laterally displace as close as possible to the outbound shipping lane. In 2019, the second trial year, a 1,000m buffer between the outbound shipping lane and the inshore lateral displacement area was added and has remained in place for each subsequent year. The 2017 baseline period was selected to mirror the 2019 temporal and spatial parameters.*

Tug transits were classified based on the proportion of the trip conforming to the vessel’s presence in the outbound shipping lane (“outbound lane”) or the Inshore Lateral Displacement Zone (“Inshore Displacement Zone”). In 2022, 97% of tug transits had greater than or equal to 50% presence in these two zones. This is a significant increase from prior years and is the highest achieved participation to date. Figure 4 visualizes the participation rates per year.

Figure 4: Participation in the Strait of Juan de Fuca lateral displacement 2018 – 2022

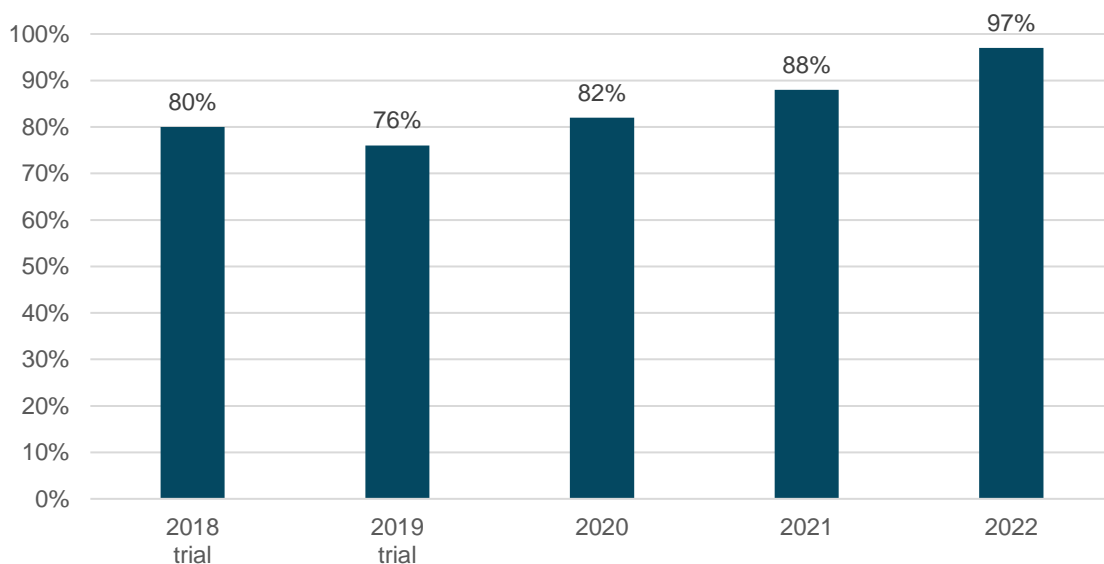


Table 2 presents a breakdown of tug transits by zone (as defined in Figure 1: Study area zones for the Lateral Displacement Initiative since 2019). 73% of participating tug transits spent more than half of their transit in the outbound shipping lane, and 24% spent more than half of their time in the inshore lateral displacement zone. The three transits that did not participate (3% total) spent more than half of the transit in either the buffer zone or the enhanced management area. Through discussions with some of these tugs, it was determined that the coordinates of the zones needed to be updated in their GPS system, causing them to unintentionally transit through the buffer or enhance management areas. This was since corrected in mid-June.

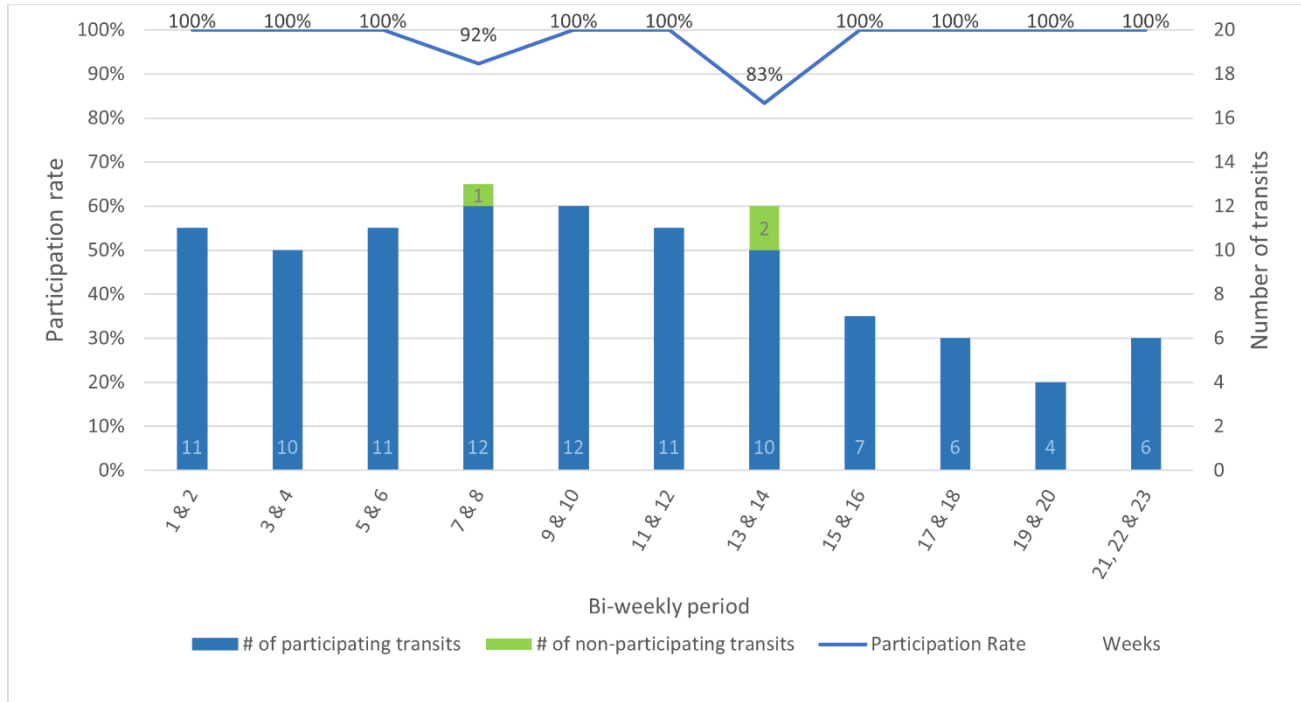
Table 2: Breakdown of tug transits by zone for 2022

Zone tug was present in for >50% of the transit	Number of tug transits	Percentage of tug transits
Outbound shipping lane (<i>participating zone</i>)	75	73%
Buffer zone	1	1%
Inshore lateral displacement zone (<i>participating zone</i>)	25	24%
Enhanced management area	2	2%
<i>Did not spend 50% of transit in any one zone</i>	0	0%
Total tug transits in 2022	103	

2) TEMPORAL DISTRIBUTION

The bi-weekly participating rate and the number of participating and non-participating transits are shown in Figure 5. The lowest percentage of participation (83%) occurred in the 7th bi-weekly period (weeks 13 & 14), while there was participation at or near 100% otherwise throughout the initiative.

Figure 5: Bi-weekly participation analysis (trips $\geq 50\%$ in the outbound shipping lane and inshore displacement zone considered participating)



3) SPATIAL DISTRIBUTION

The tug traffic distribution patterns shown in Figure 6 provide a comparison of the position reports for 2017, and 2019 through 2022.

Figure 6: Distribution Analysis for Tugs by year, 2017 and 2019 to 2022.

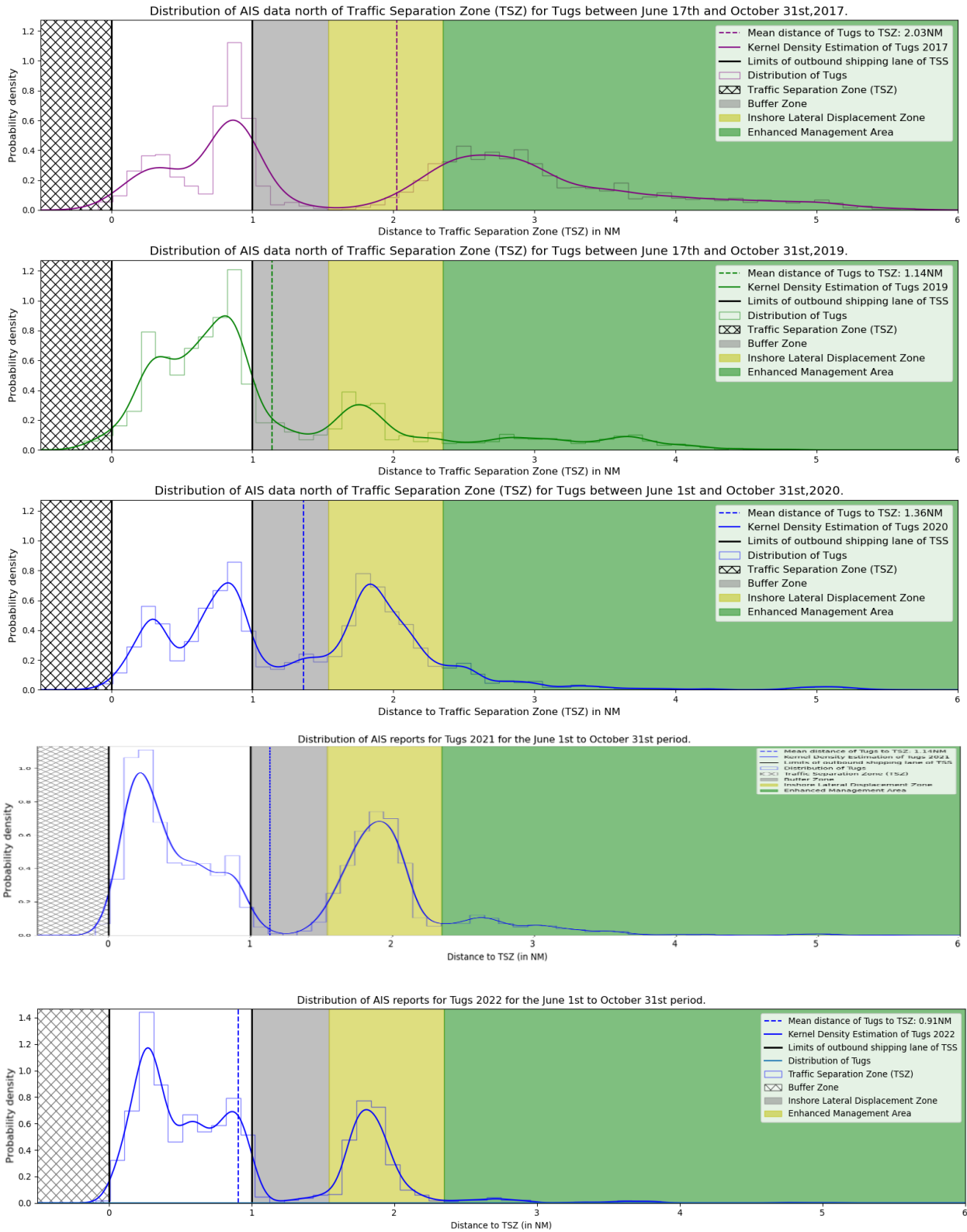


Figure 6 is a cross section of the various zones analyzed for tug transit presence in the Strait of Juan de Fuca from 2017 to 2022 (excluding 2018). The bottom distribution shows the tug density for 2022, with two distinct modes of high tug traffic density in the outbound shipping lane (white area) and the inshore lateral displacement zone (yellow area). There are clear dips in traffic within the buffer zone (grey) and the Enhanced Management Area for Southern Resident killer whales (green), which demonstrates the high participation rate for this year.

Within the outbound shipping lane of the Traffic Separation Scheme (white area) tug traffic has presented two modes of density, one showing a higher distribution further away from the Traffic Separation Zone (cross-hatched area).

Overall, the mean distance to the Traffic Separation Zone varied over the years, listed below:

- 2.05 NM in **2017** (baseline)
- 1.14 NM in **2019** (0.91NM further away from EMA compared to 2017)
- 1.36 NM in **2020** (0.69NM further away from EMA compared to 2017)
- 1.14 NM in **2021** (0.91NM further away from EMA compared to 2017)
- **0.91 NM in 2022** (1.14 NM further away from EMA compared to 2017)

The increased change in distance away from the EMA compared to baseline in 2022 over 2021 is indicative of the higher participation rate and the high density of tugs in the outbound shipping lane.

IV. CONCLUSION

The effect of the initiative is clearly apparent by the reduced distribution within the Enhanced Management Area, with higher density of tugs in both the outbound shipping lane of the TSS and the Inshore Lateral Displacement Zone.