

Evaluating Changes in Sound Field Levels in the Salish Sea Resulting from Trials of Vessel Slowdown, Lateral Displacement and Exclusion from Interim Sanctuary Zones in 2022, 2023 and 2024

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EVALUATING CHANGES IN SOUND FIELD LEVELS IN THE SALISH SEA
RESULTING FROM TRIALS OF VESSEL SLOWDOWN, LATERAL
DISPLACEMENT AND EXCLUSION FROM INTERIM SANCTUARY ZONES
IN 2022, 2023 AND 2024

By

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LIST OF ACRONYMS

AIS: Automatic Identification System

dB: Decibel

CPA: Closest Point of Approach

DFO: Fisheries and Oceans Canada/ Government of Canada

DST: Daylight savings time (UTC-7 hours)

ECHO: Vancouver Fraser Port Authority's Enhancing Cetacean Habitat and Observation Program

Hz: Hertz

ISZ: Interim Sanctuary Zone

IQR: Interquartile range measured from the 25th to the 75th percentile.

kHz: kiloHertz

Leq: Equivalent continuous sound level, also known as the time-average sound level.

m: meter

OPP-MEQ: Ocean Protection Plan-Marine Environmental Quality Program

PSD: Power Spectral Density

rms: Root Mean Square

SL: Source Level

SPL: Sound Pressure Level

SRKW: Southern Resident Killer Whale

TC: Transport Canada / Government of Canada

TSS: Traffic Separation Scheme

VRZ: Vessel Restriction Zone

ABSTRACT

Fournier, M., Burnham, R., and Vagle, S. 2026. Evaluating Changes in Sound Field Levels in the Salish Sea Resulting from Trials of Vessel Slowdown, Lateral Displacement and Exclusion from Interim Sanctuary Zones in 2022, 2023 and 2024. Can. Tech. Rep. Fish. Aquat. Sci. 3732: vi + 113 p. <https://doi.org/10.60825/wsbr-d706>

Changes in underwater sound levels resulting from voluntary slowdowns, lateral displacement of tugs, and exclusion of vessels in an Interim Sanctuary Zone from 2022 - 2024 in the Salish Sea were examined. These measures aim to reduce the acoustic impact on southern resident killer whales (*Orcinus orca*, SRKW) using this area in the summer months.

Analysis of slowdown trials on Swiftsure Bank showed participation exceeded 80% across all three years. However, most vessels were only required to reduce speed by 1 knot or less to participate. Bulkers and tankers reduced their speed, on average, by 0.5 knots while containerships and vehicle carriers reduced by 1 knot, on average. Reductions in underwater sound levels were not reliably seen, with increases in low-frequency noise during the trial period likely attributable to fishing vessel activity.

Participation in the Haro Strait-Boundary Pass slowdown trials surpassed 86% annually. Here, the reduction in speed was greater. Bulkers and tankers reduced their speed by 1.0 knot, on average, whereas containerships and vehicle carriers showed an average of 2.5 knots, reduction. However, a decrease in sound pressure levels was still not consistently seen in this area.

A lateral displacement applied to tugs only showed no measurable change in sound levels, since the vessels were already operating within the lateral displacement zones or designated shipping lanes during control periods, and so showed no difference in transit route through the trial. Compliance with Interim Sanctuary Zones (ISZ) was limited, particularly by small, non-commercial vessels. Noise from shipping lanes influenced the recordings in these regions, underscoring the persistent impact of commercial traffic on the marine soundscape. These findings highlight both the value and limitations of mitigation measures in reducing vessel noise impacts on marine ecosystems.

RÉSUMÉ

Fournier, M., Burnham, R., and Vagle, S. 2026. Evaluating Changes in Sound Field Levels in the Salish Sea Resulting from Trials of Vessel Slowdown, Lateral Displacement and Exclusion from Interim Sanctuary Zones in 2022, 2023 and 2024. Can. Tech. Rep. Fish. Aquat. Sci. 3732: vi + 113 p. <https://doi.org/10.60825/wsbr-d706>

Les variations des niveaux sonores sous-marins observées entre 2022 et 2024 dans la mer des Salish et attribuables aux ralentissements volontaires, au déplacement latéral des remorqueurs et à l'exclusion des navires dans une zone sanctuaire provisoire ont été examinées. Ces mesures visent à réduire l'impact acoustique sur les épaulards résidents du sud (*Orcinus orca*, ERS) qui fréquentent cette zone pendant les mois d'été.

L'analyse des essais de ralentissement menés sur le banc Swiftsure a montré que le taux de participation a dépassé 80% au cours des trois années. Toutefois, la plupart des navires n'étaient tenus de réduire leur vitesse que d'un nœud ou moins pour participer. En moyenne, les vraquiers et les pétroliers ont réduit leur vitesse de 0,5 nœud, tandis que les porte-conteneurs et les transporteurs de véhicules l'ont réduite de 1 nœud. Les réductions des niveaux sonores sous-marins n'ont pas été observées de manière fiable, l'augmentation des bruits à basse fréquence pendant la période d'essai étant probablement attribuable à l'activité des navires de pêche.

La participation aux essais de ralentissement dans le détroit de Haro et le passage de Boundary a dépassé 86% chaque année. Dans ce secteur, la réduction de vitesse était plus importante. En moyenne, les vraquiers et les pétroliers ont réduit leur vitesse de 1,0 nœud, tandis que les porte-conteneurs et les transporteurs de véhicules ont présenté une réduction moyenne de 2,5 nœuds. Cependant, aucune diminution constante des niveaux de pression acoustique n'a été observée dans cette zone.

Le déplacement latéral appliqué uniquement aux remorqueurs n'a entraîné aucun changement mesurable des niveaux sonores, car les navires circulaient déjà à l'intérieur des zones de déplacement latéral ou des voies de navigation désignées durant les périodes témoins et ne présentaient donc aucune différence de trajectoire pendant l'essai.

Le respect des zones de sanctuaire provisoires (ISZ) est demeuré limité, en particulier de la part des petites embarcations non commerciales. Le bruit provenant des voies de navigation a influencé les enregistrements dans ces régions, soulignant l'impact persistant du trafic commercial sur le paysage sonore marin. Ces résultats mettent en évidence à la fois l'utilité et les limites des mesures d'atténuation visant à réduire les effets du bruit des navires sur les écosystèmes marins.

1. EXECUTIVE SUMMARY

Management strategies such as vessel slowdowns, rerouting, and exclusion zones have proven effective in reducing underwater noise and mitigating acoustic disturbances to marine mammals. However, growing vessel traffic and increased whale exposure to vessels may reduce these measures' effectiveness. Measures have been trialed in the Salish Sea to lessen the acoustic impact to the endangered southern resident killer whales (*Orcinus orca*, SRKW) since 2017. This study evaluates voluntary participation and effectiveness of vessel slowdowns at Swiftsure Bank and Haro Strait-Boundary Pass, tug lateral displacement through Juan de Fuca Strait, and compliance to vessel exclusion within Interim Sanctuary Zones at key SRKW foraging locations during the summers of 2022, 2023 and 2024. The goal was to reduce broadband ambient noise (10 Hz -100 kHz) and noise within frequencies critical to SRKW communication (500 Hz - 15 kHz) and echolocation (15 kHz - 100 kHz).

Assessment of the slowdown trials at Swiftsure and Haro Strait-Boundary Pass were made through comparing sound pressure levels during the trial to control periods of several months before and after the measures were in place. Reducing vessel speed was identified as the most effective operational method to lower acoustic impacts on SRKW. Nonetheless, minimal changes were observed in SRKW communication and echolocation frequency bands between control periods (pre- and post-trial) and trial periods when the measures were in place. Consistent notable reductions comparing control and trial periods were not seen. For Haro Strait-Boundary Pass slowdown in particular, the lack of clear reductions in noise levels were further investigated by considering the number of vessels in the area during control and slowdown periods, and the time that SRKW might be exposed to vessels. Despite participation rates being high, the change in speeds to be considered as participating in the trial on average was not substantial for either slowdown region when comparing typical speeds during control periods. This would lessen the reductions seen in noise levels.

Tug lateral displacement showed the least change, since most transits were already transiting within designated zones before the trial, with no change in routing when comparing control and trial periods.

Finally, increased summer vessel activity and poor compliance with Interim Sanctuary Zones vessel exclusions diminished potential reductions in sound pressure levels in these zones. Also anthropogenic noise originating from shipping lanes persistently altered the acoustic characteristics of these regions, emphasizing the influence of commercial maritime traffic on the underwater soundscape.

2. INTRODUCTION

Studies have shown that underwater-radiated noise from commercial ships may have both short and long-term negative consequences on marine life, especially marine mammals (Richardson et al., 1995; Southhall et al., 2007, 2019; Weilgart, 2007). In the Northeast Pacific, increasing commercial shipping activity has led to elevated ambient sound levels, particularly along shipping routes and in proximity to major ports and coastal cities (Richardson et al., 1995; Andrew et al., 2002; NRC, 2005; McDonald et al., 2006; Hildebrand, 2009; Chapman and Price, 2011; Frisk, 2012; Merchant et al., 2014; Pirotta et al., 2019). This acoustic pollution can disrupt essential biological functions in many marine organisms, including navigation, communication, and foraging.

Among the species impacted is the southern resident killer whale (SRKW, *Orcinus orca*), whose population recovery is hindered by four major threats: acoustic disturbance, particularly from vessel noise, vessel strike, decreased prey abundance and availability, and contamination from persistent organic pollutants (DFO, 2017, 2018, 2021; Raverty et al., 2020). The SRKW population, which feeds exclusively on fish, particularly Chinook salmon (*Oncorhynchus tshawytscha*), has declined to approximately 73 individuals as of 2025 (Center for Whale Research, 2025). This population is currently listed as Endangered under both Canada's *Species at Risk Act* (SARA) and the American *Endangered Species Act* (ESA) (Krahn et al., 2004).

The acoustic modality is fundamental to SRKW and is their principal means of sending and receiving information about their environment using echolocation clicks, whistles, or calls. Echolocation is used to form a cognitive image of their surroundings, and so, plays a role in navigation and prey location and capture (Ford, 1989; Au et al., 2004). The whistles and calls are used to communicate between conspecifics during social interactions, or when working in hunting groups. Anthropogenic noise, particularly from vessel traffic, introduces broadband acoustic energy into the marine environment that overlaps with the frequency ranges used by SRKW for communication and echolocation (Veirs et al., 2016). Chronic noise exposure has been shown to mask biologically important signals, reduce foraging efficiency, and contribute to behavioral disturbance (see Burnham et al. 2023, 2025). Tennessen et al. (2024) recently provided further empirical evidence that vessel noise impairs the ability of SRKWs to efficiently locate and hunt prey, particularly for females, who were more likely to abandon prey capture attempts in the presence of vessel noise. Consequently, vessel noise has been identified as a key limiting factor in SRKW population recovery and survival (Weilgart, 2007; Lacy et al., 2017; DFO, 2018; Raverty et al., 2020).

Southern residents are often present in the the Salish Sea, the collective name for the waters surrounding southern Vancouver Island and northern Washington State, particularly during the summer months. SRKWs exhibit strong site fidelity to specific foraging habitats during this time, including Swiftsure Bank, the Strait of Juan de Fuca, Haro Strait on the west side of San Juan Island, Boundary Pass, Swanson Channel, and southern portions of the Strait of Georgia (DFO, 2022). Much of the Salish Sea, and areas on Swiftsure Bank, have been designated as critical

habitat for SRKW under recovery planning initiatives in both Canada and the United States due to their importance in supporting SRKW foraging behavior (Balcomb and Bigg, 1986; DFO, 2017; Olson et al., 2018). Key habitat features of areas identified as foraging regions include steep bathymetric gradients, shallow reef systems adjacent to deep waters, and strong tidal currents that serve to aggregate prey (Groot et al., 1984; Heimlich-Boran, 1988; Hauser et al., 2007; Hanson et al., 2010; Olson et al., 2018; Vagle et al., 2021).

The Salish Sea has high rates of commercial vessel traffic transiting in international shipping lanes to ports including Victoria, Vancouver, Tacoma, Port Angeles, and Seattle. Increased shipping activity has led to elevated ambient noise levels in key SRKW foraging areas. On average, ship transits raise ambient noise levels by 20-30 decibels (dB) at frequencies below 1,000 Hz, and by 5-13 dB at frequencies as high as 96,000 Hz at ranges less than 3 km, which is well within the range used by killer whales for echolocation and communication (Veirs et al., 2016). This broadband noise can effectively mask SRKW calls and echolocation clicks, disrupting essential biological functions like navigation, communication, and prey detection (Richardson et al., 1995; Hildebrand, 2009; Frisk, 2012). Cominelli et al. (2019) noted overlap of key foraging areas with major commercial shipping lanes and recreational boating zones, prompting the implementation of several noise mitigation strategies. Since 2017, voluntary vessel slowdowns, lateral displacement of shipping traffic, and the establishment of government-mandated Interim Sanctuary Zones (ISZs) have been implemented to reduce noise exposure in critical SRKW habitats (MacGillivray et al., 2019; Joy et al., 2019). These measures are designed to minimize the overlap between vessel noise and SRKW communication and echolocation. These initiatives are coordinated through the Vancouver Fraser Port Authority-led Enhancing Cetacean Habitat and Observation (ECHO) Program and supported by federal agencies, including Transport Canada (TC), Fisheries and Oceans Canada (DFO), the Canadian and U.S. Coast Guards, and industry stakeholders.

Voluntary vessel slowdown trials have been introduced to reduce noise emissions, initially covering a section of Haro Strait, and later expanded to include Boundary Pass and Swiftsure Bank (Joy et al., 2019; MacGillivray et al., 2019; Burnham et al., 2021, 2025, Vagle and Burnham, 2023). Speed reduction targets vary by vessel type, with bulkers, tankers, ferries, and government vessels requested to slow to 11 knots, and container ships, cruise liners, and vehicle carriers to 14.5 knots. The first voluntary slowdown trial occurred in 2017 over a 31 km stretch of Haro Strait in the Compulsory Pilotage Area (Pilotage Act 1985, see Table 1 in the Appendix). Although the focus of the slowdown request was piloted commercial vessels over 350 gross tons, and pleasure craft over 500 gross tons, all vessels were encouraged to reduce their speed when it was safe and feasible. Results showed that reducing vessel speed lowered underwater noise levels (MacGillivray et al., 2019). In 2019, the trial area expanded to 55 km, covering both Haro Strait and Boundary Pass. Participation rose from 61% in the first year to over 80% in 2018 and 2019. This resulted in decreases in ambient noise, particularly in the low frequencies (MacGillivray et al., 2017, 2019; Joy et al., 2019). In 2020, a vessel slowdown at Swiftsure Bank was introduced in

the outbound shipping lane, which was expanded to include the inbound shipping lane in 2022, to cover approximately 43 km of Swiftsure Bank.

In 2018, a lateral displacement trial was conducted, directing outbound deep-sea vessels in Juan de Fuca Strait to shift southward, away from known SRKW foraging areas, in hopes of reducing both physical and acoustic disturbance (Olson et al., 2018). However, movement was limited for larger commercial vessels, which only allowed for their transit to shift approximately 600 m southward, resulting in little effect on the ambient noise level. The transit of tugs through this area is not restricted to shipping lanes; their passage through Juan de Fuca is often closer to the coastline than the shipping lanes, even when not transiting port-to-port (Cominelli et al., 2019). Therefore, for the same trial an average shift of approximately 3900 m, and up to 5000 m or more, was possible for tugs (Vagle and Neves, 2019). Tugs showed high participation, significantly reducing noise in the higher frequencies of the soundscape per vessel transit (Vagle and Neves, 2019). Since 2019, trials have focused on tugs and barges only, with some trials achieving up to 7 dB reductions in broadband noise and over 11 dB reductions at higher frequencies for each tug transit (Vagle, 2020). Initial acoustic benefits were limited for larger vessels, but the tug and barge displacement trials since 2019 have yielded significant reductions in noise levels when considered on a individual vessel passage basis from the displacement. This was particularly the case in SRKW-relevant frequency bands when measured per vessel passage (Vagle, 2020; Burnham et al., 2021, Burnham and Vagle, 2023) and therefore, remained operational for the 2022, 2023 and 2024 seasons.

Since 2019, Interim Sanctuary Zones (ISZs), which restrict vessel access in key SRKW feeding areas including Swiftsure Bank, Swanson Channel, and East Point, have been introduced as additional protective measures (Olson et al., 2018). These are the only mandatory measures currently in place in the Salish Sea, and are in place annually from June 1st to November 30th. These areas are closed to all vessel types, with enforcement led by Parks Canada. However, compliance, particularly among recreational boaters, has been low (Vagle, 2020; Burnham et al., 2021, Burnham and Vagle, 2023). The zone at East Point and in Swanson Channel have remained unchanged since their establishment in 2018, even though new data on SRKW habitat use, including evidence of shifts in important foraging areas in recent years, has emerged. The ISZ on Swiftsure Bank was modified in extent and made into a slowdown region in 2022, mandated and monitored by Transport Canada.

This report presents results evaluating the changes in sound levels resulting from management measures in place using acoustic recordings and vessel tracking data from 2022 to 2024 in Swiftsure Bank, Jordan River in the Strait of Juan de Fuca, Haro Strait, Boundary Pass, Swanson Channel and Saturna Island in the southern Gulf Islands. Using passive acoustic monitoring data from near-seabed moorings, ambient noise levels in broadband (10 Hz - 100 kHz), SRKW communication (500 Hz - 15 kHz), and echolocation (15 - 100 kHz) frequency ranges were assessed during trial and control (pre- & post-trial) periods. Vessel traffic data supported analysis of participation rates and overall success of the interventions. Measures of the effectiveness of the trials are two-fold. First, the level of voluntary participation to the slowdown and displacement

measures, and compliance to the exclusion zones by mariners were established. Secondly, the changes in the sound fields between the control and trial conditions were examined. Although the analysis considers the effect of overall ambient noise changes resulting from the management measures, the soundscape changes in the frequency bands used by SRKW, for example for foraging and communication, were also considered. These findings build on previous years' evaluations (Vagle and Neves, 2019; Vagle, 2020; Burnham et al., 2021; Burnham and Vagle, 2023) and contribute to the broader understanding of acoustic management in SRKW critical habitat, offering insight into how best to refine future conservation strategies.

3. METHODS

3.1 Mooring locations and acoustic recordings

The passive acoustic recordings for this study were made as part of a larger scoped project under the Ocean Protection Plan - Marine Environmental Quality Program (OPP - MEQ) under the Government of Canada. Eleven moorings are in place within the Salish Sea with five of those being used to assess changes in soundscape in trial areas for this study. Moorings at Swiftsure Bank, Haro Strait and Boundary Pass were used to assess slowdown measures using continuous recordings (Figure 1, Table 1). The mooring at Jordon River was used to assess lateral displacement, while the mooring south of Pender Island was deployed to monitor the soundscape in the Swanson Channel ISZ (Figure 1, Table 1). The ISZ at Saturna Island (East Point) and slowdown region enforced by TC at Swiftsure Bank were not assessed acoustically for these analyses.

This monitoring program is centered around SRKW with recorder locations focused within SRKW critical habitat. Mooring deployment sites were chosen based on sightings data, which highlighted areas where SRKW were most frequently seen and thought to use for foraging (DFO, 2021; Thornton et al., 2022; Stredulinsky et al., 2023).

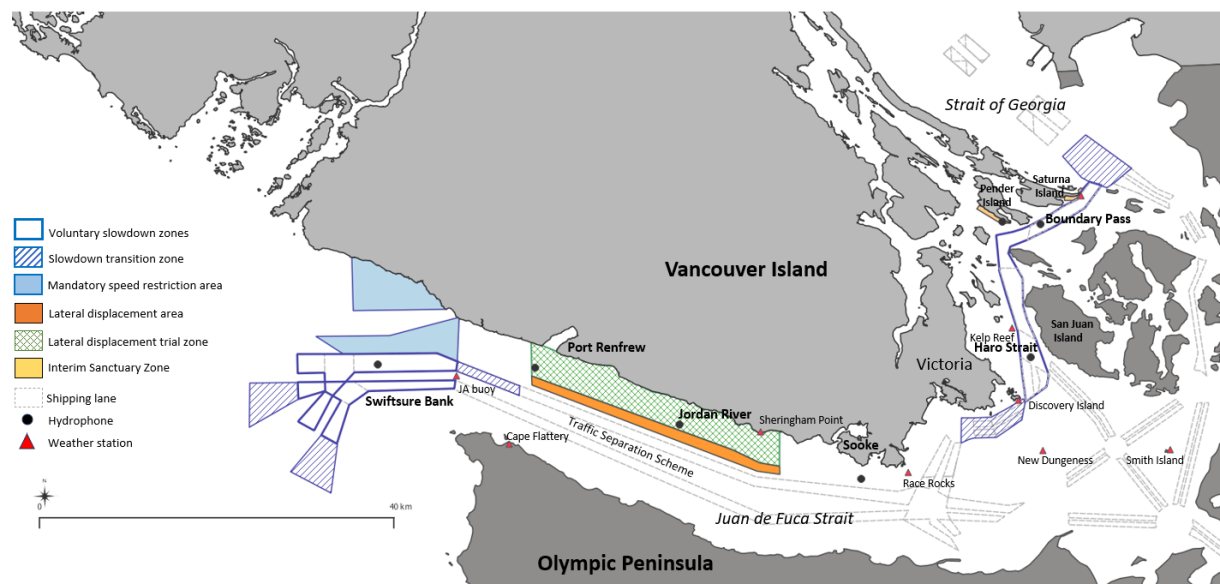


Figure 1: Locations of all management actions undertaken in the Salish Sea during 2022, 2023 and 2024. Commercial shipping lanes are shown for reference (light grey). Hydrophones used for the analysis are indicated by black circles, while weather stations are indicated with red triangles.

Table 1: Hydrophone mooring locations, water depths and the management measures used for assessment.

Hydrophone	Location	Measure	Water Depth (m)
Swiftsure Bank, outbound lane	48.515N, 124.936W	Slow down	77
Jordan River	48.397N, 124.134W	Lateral displacement of tugs and barges	120
Haro Strait	48.49583N, 123.192783W	Slow down	235
Boundary Pass	48.733567N, 123.145683W	Slow down	180
Swanson Channel	48.7393N, 123.257W	Interim Sanctuary Zone	72

The recorders used to assess the slowdowns were deployed directly in the trial zones (Figure 1, Table 1). The hydrophone used to assess the lateral displacement was deployed at Jordan River, following an assessment of the most effective recorder location to do this (Vagle and Neves, 2019). This recorder is located approximately halfway through the trial zone from where tugs and barges are being displaced, and sits approximately 5 km north of the outbound traffic lane, which has previously been assessed to best represent these management measures in Juan de Fuca Strait (Vagle and Neves, 2019, Vagle, 2020, Figure 1, Table 1).

The continuous underwater passive acoustic recordings were made using JASCO Applied Sciences Ltd G4 Autonomous Multichannel Acoustic Recorders (AMAR) equipped with GeoSpectrum Technologies Inc (GTI) M36-100 hydrophones. Hydrophones were calibrated by GTI from 100 Hz-250 kHz, and the AMAR-hydrophone pairing sensitivities were certified by JASCO Applied Sciences Ltd at 250 Hz. In-house calibrations were conducted for each instrument pairing once per year in the very low frequency range (1-700 Hz) and the high frequency range (2-100 kHz). An additional single point pistonphone calibration at 250 Hz was completed before each deployment. The AMAR-hydrophone pairs were then mounted onto quiet moorings and deployed with the hydrophones situated approximately 2 m above the seafloor. Continuous recordings were made at a sample rate of 256 kHz with 24-bit resolution. Data was stored on internal SD memory cards as wav files until the mooring retrieval. The acoustic wav files were then processed using custom Python scripts, modified from those used by Merchant et al. (2015). Five-second power spectra were computed using a 1-second Hanning window, a 50% overlap, and Welch's averaging. From this, sound pressure level (SPL) measures were calculated as one-minute averages that subsequently were averaged to longer periods of interest. Comparisons of minute-wise, hourly, and monthly median levels of pre-, during, and post-trial recordings were used in this assessment.

3.2 Acoustic analysis

Comparisons of sound levels in the frequencies of interest were made from pre- and post-trial control periods and the trial period when measures were in place. The pre-trial period was April and May, trial periods ran from June 1st each year, and the post-trial period was from the conclusion of measures, which varied for each year, until the end of the calendar year. Broadband ambient

noise in the 10 Hz to 100 kHz frequency range was evaluated for changes between pre-/post- and trial recordings. This range represents the frequencies for which, if noise levels were increased, there may be behavioral or physiological implications for SRKW (Heise et al., 2017). Killer whale vocalizations are typically between 500 Hz and 15 kHz; noise from vessels in this range could obscure conspecific calling or social behaviors linked to group cohesion and coordination. Echolocation occurs in the frequency range of 15 - 100 kHz, therefore, acoustic additions in this range could mask signal echoes, impairing navigation, orientation, and prey location and capture (Heise et al., 2017). The additions of vessel noise to these ranges were further examined by considering frequency ranges that represent vessel metrics (Table 2). The decadal band of 100-1000 Hz, and 1/3-octave frequency ranges centered around 63 Hz and 125 Hz, were used to indicate commercial vessel presence without influence from water turbulence in the lower frequencies (Table 2, Merchant et al., 2012, 2015). In addition, the metrics are consistent with assessments made in the EU (Merchant et al., 2022). The 50 kHz frequency range (49.5-50.5 kHz) was used to detect the presence of small vessel traffic in the trial areas (Burnham et al., 2021; Vagle et al., 2021; Burnham and Vagle, 2023).

Table 2: Frequency ranges of interest for analysis, including SRKW communication and echolocation bands, and vessel presence markers.

Frequency range (Hz)	Description
10-100,000	General ambient noise, implications for behavioural change or stress in SRKW (Heise et al. 2017)
500-15,000	Communication calls (whistles, pulsed tones, etc.) of SRKW (Heise et al. 2017)
15,000-100,000	Echolocation in SRKW (Heise et al. 2017)
10-100	Low frequency vessel noise, water turbulence (Merchant et al. 2012)
100-1000	Vessel presence marker, excluding water turbulence effects (Merchant et al. 2012)
1000-10000	Vessel marker, used in the small vessel detector (Warner et al. 2020)
10000-100000	Vessel marker, used in the small vessel detector (Warner et al. 2020)
49500-50500	Vessel marker, 50 kHz signal is often used in fish finders (Warner et al. 2020)

Recordings from trial periods were compared to the levels recorded from pre- and post-trial recordings to establish efficacy of the management actions. To minimise any confounding variables, restrictions on the data analysed were made through a filtering process described in Section 3.4.

To evaluate the changes in ambient noise from each of the mitigation measures, a cumulative distribution function (CDF) SPL analysis was conducted. The L_5 , L_{25} , L_{50} , L_{75} , and L_{95} exceedance levels were obtained for each recording using only data that satisfied restrictions to minimize potential current flow and wind noise in the recordings to better assess the input from commercial vessels. Here L_{95} represents the general baseline quiet ambient conditions which are exceeded 95% of the time, L_{25} and L_{75} quartile levels, L_{50} represents the median and levels of noise 50% of the time, and L_5 gives the upper level of noise inputs, present for a small proportion (5%) of the recordings. The L_{50} exceedance level is used frequently in noise comparisons to represent typical sound levels (e.g., Klinck et al., 2012; Merchant et al., 2012), whereas the L_{95} and L_5 levels indicate the range of sound levels present, and help characterize both the background ambient

noise level (L_{95}) and periods of elevated noise that may mask SRKW acoustic signals or initiate behavioral change (Clark et al., 2009; Merchant et al., 2015). Changes were evaluated by comparing sound pressure levels (SPL) from mooring recordings and vessel tracking data during the trial periods with those from control periods - specifically, the two months preceding and at least one month following the trials.

3.3 Vessel Presence through Automatic Identification System (AIS)

Automatic Identification Systems (AIS) data were received from the Canadian Coast Guard (CCG) terrestrial receivers for the control and trial periods for Class A and Class B vessels. Class A vessels primarily consist of larger commercial ships, whereas Class B vessels are predominantly recreational craft, with some smaller commercial and fishing vessels included. Class A are all vessels over 300 tons (excluding fishing vessels) and passenger vessels over 150 tons and/or carrying more than 12 passengers, for which AIS transceivers are mandatory. Towage and escort vessels of any tonnage must also carry a Class A transceiver. The AIS data included the name, identification number, type, and geographic location of the vessel at intervals of 5 to 30 seconds. These raw AIS data were cleaned and aggregated into 5-minute time bins, from which vessel trajectories and speeds were interpolated. Class A vessels were further categorized into the following types: (1) Bulk carriers, (2) Container ships, (3) Ferries, (4) Fishing vessels, (5) Passenger vessels, (6) Tankers, (7) Tugs, (8) Vehicle carriers, (9) Registered whale-watching vessels, and (10) Other: government/research vessels, naval vessels, recreational vessels as well as any unidentified vessels.

Vessel presence, quantified from hourly AIS track data, was used to assess participation in trials and establish the vessel-derived input to the soundscape for both control and trial periods. For the slowdown trial areas in Haro Strait and Boundary Pass, and the ISZ in Swanson Channel, the area over which the impact of vessels was considered was restricted by the geography, constrained by islands or landmasses (Figure 2). In these cases, the maximum distance for vessel presence analysis was the obstruction or, whenever possible, out to a maximum distance of 8 km (Figure 2). In the more open water areas, vessel presence up to a maximum distance of 8 km was considered, to restrict the analysis to vessels within the shipping lanes, or waters immediately proximal to the trial zones (Figure 2). For the slowdown program at Swiftsure Bank, the analysis of vessels was restricted to a maximum distance of 8 km from the mooring, covering the in- and out-bound lanes. The maximum distance of 8 km for the lateral displacement trial includes the waters from the Jordan River mooring to the outbound shipping lane, but not as far as the inbound lane.

The 8 km limit is greater than the estimated detection range of SRKW communication calls in Juan de Fuca Strait and on Swiftsure Bank, which at its maximum was estimated to be 6.5 km (Mouy et al., 2020). Abiotic noise (wind and current) during the summer months is presumed to be lowest; however, we used the conservative 8 km distance to recognize that noise from wind, waves, water movement, and precipitation makes substantial additions to the soundscape (Vagle

et al., 1990; Medwin et al., 1992; Richardson et al., 1995; Nystuen, 1996; Nystuen and Ma, 2002; Pensieri et al., 2015).

Overall soundscape changes resulting from the lateral displacement have been established in previous years with recent results showing limited change in the overall soundscape, but reduction of noise emission from passing tugs (Vagle and Neves, 2019; Vagle, 2020; Burnham et al., 2021).

Participation in vessel slowdowns, lateral displacements, and compliance with ISZs was evaluated using AIS data. These data were also used to compare vessel transit rates - both hourly and daily - between control and trial periods. AIS Class A vessel transits were analyzed primarily within slowdown zones, while tugboat movements were the focus for lateral displacement assessments. For ISZ compliance, AIS Class B data were analyzed, with additional consideration given to the presence of commercial vessels due to their proximity to established shipping lanes. As recreational vessels and smaller commercial vessels are not required to carry AIS systems, and transmit Class B AIS voluntarily it must be kept in mind that this analysis represented the minimum number of vessels passing by or within the ISZ zones for the control and trial periods.

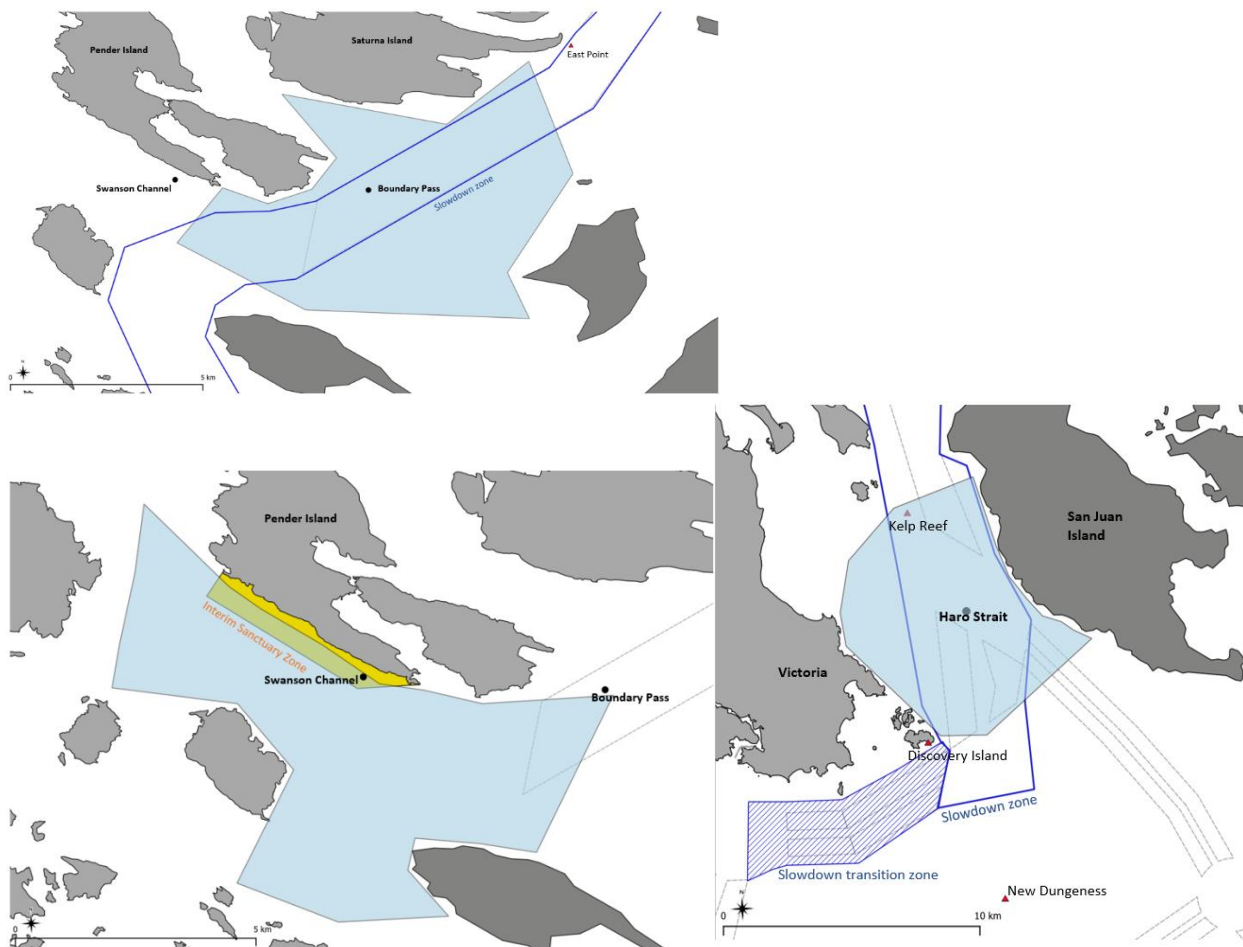


Figure 2: Areas of slowdown analysis through Boundary Pass (top left), Haro Strait (bottom right) and the Swanson Channel ISZ (bottom left) are shown with blue shading. Moorings are shown with black circles, and weather buoys with red triangles.

3.4 Limiting Variables

Restrictions on the data analyzed were made to limit abiotic (natural, non-biological) noise additions, which could obscure the SPL changes that could have resulted from the management measures. To minimize this effect, potential noise inputs from water currents and wind were considered. Only recordings made during slack tides, when current speeds were less than 0.3 ms^{-1} , were used. Current was measured at each mooring site through current meters attached to the mooring itself (JFE Advantech Co. Ltd. Infinity-EM electromagnetic current meters). It was assumed, after comparison to Webtide measures (Hannah et al., 2008), that the currents measured at the mooring were representative of surface currents. Similarly, only recordings where wind speeds did not exceed 5 ms^{-1} , were used. Wind speed measures were taken from hourly weather and sea state reports from the Sheringham Point weather buoy (48.840 N, 126.000 W, Figure 3) for Swiftsure Bank and Jordan River assessments, Smith Island weather station for Haro Strait and East Point weather station on Saturna Island for the IZSs in the Gulf Islands (Figure 3).

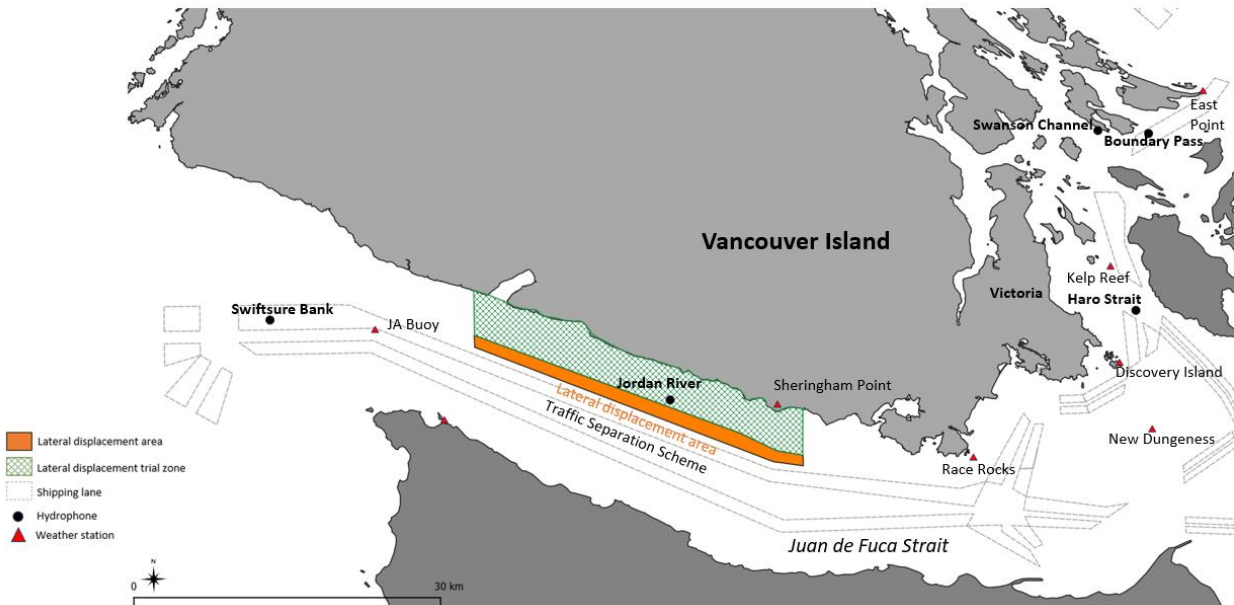


Figure 3: A map of the passive acoustic moorings (black circles) and respective weather stations (red triangles). Shipping lanes (light grey hashing), Management Enhancement Area (green hashed shading), and Inshore Lateral Displacement Area (orange shading) are shown.

Acoustic additions from small vessels may contribute significantly to the overall noise levels, and potentially mask the change in the sound field resulting from the conservation measures. The use of Class B data represented the minimum presence of small vessels, but many more were expected to be present and not be equipped with AIS transponders. In an effort to reduce the impact of these vessels in the soundscape assessments for the slowdown trials, a small vessel detection algorithm, based on the approach by Warner et al. (2020), was also implemented. This

small vessel detector aimed to identify small vessels both moving slowly and at speed in the acoustic data to be removed, but retain signals for vessels subject to the trial measures. The detector used hourly median SPL levels in three decadal bands, comparing observed SPL values to threshold SPL values in decibels (dB). Exceedances in SPL at or above the threshold values compared to hourly values were a determinant of small vessels (Warner et al., 2020). The frequency band 100-1000 Hz has previously been used successfully as an indicator of vessel presence (Merchant et al., 2012, 2015). For the small vessel detector, an increased amplitude in this band by 6 dB, together with SPL elevated by 5 dB in the range 1-10 kHz and by 23 dB in the 10-100 kHz compared to an hourly median, indicated small vessels moving at speed. In addition, for small vessels moving slowly, this same definition was used, but with SPL in the 100-1000 Hz range exceeding the hourly median by 6 dB, but by no more than 9 dB (Warner et al., 2020). The precision (95.4%) and efficacy of the detector was established for a test dataset by both manual review of the acoustic data and comparison to visual observations, noting the number of small vessels around the mooring during recording (Warner et al., 2020). Those sections of data, indicated by the detector to include small vessels, were omitted from the data analyzed for slowdown and lateral displacement trials. For the ISZs. Conversely, it was only when these criteria were met that the data were used to determine the changes in the sound field as a result of Class B and small vessel presence.

3.5 Slowdown assessments

The vessel slowdown request at Swiftsure Bank applied to inbound and outbound traffic transiting an approximate 43 km section, beginning just east of the JA buoy at the start of the transition zone and extending westward to the end of the in- and outbound traffic separation scheme (Figure 4). The slowdown was applied to the in the inbound shipping lane in addition to the outbound for the first time in 2022, and this continued for 2023 and 2024. In Haro Strait and Boundary Pass, the slowdown trial zone spanned approximately 55 km, from Discovery Island in the south to East Point on Saturna Island in the north (Figure 5).

The initiation of the Haro Strait and Boundary Pass slowdown was triggered by a confirmed presence, visual or acoustic, of SRKWs. Monitoring for SRKW presence began in early June, and the slowdown measures were implemented on June 1st, for all 3 years, following a confirmed observation. These measures remained in effect until October 31st, November 30th and November 15th for 2022, 2023 and 2024, respectively, when SRKW absence had been confirmed for over two weeks after the middle of October. The pre-trial control period for this region extended from April 1st to June 1st, and post-trial from the end of the trial until December 31st for all 3 years.

In this report, participation in the Haro Strait and Boundary Pass trial was evaluated using AIS data and assessment of the proportion of vessels that slowed to the requested speed. In addition, voluntary self-reporting by vessel pilots or captains was also considered. In self-reports, captains declared their intent to comply with the requested speed. Vessels were considered compliant if their speed was within one knot of the requested target, as assessed and reported by the ECHO Program.

The Swiftsure Bank slowdown trial ran from June 1st to October 31st, for all 3 years (2022, 2023, 2024). Control periods for Swiftsure Bank included the two months prior and following the trial. For this region, although pre-trial and post-trial periods were considered, the pre- to trial period comparison was thought to be more representative of the true soundscape changes due to known seasonal variations in the Salish Sea soundscape, and impacts from offshore that are not fully accounted for (Burnham et al., 2021, Burnham and Vagle, 2023).

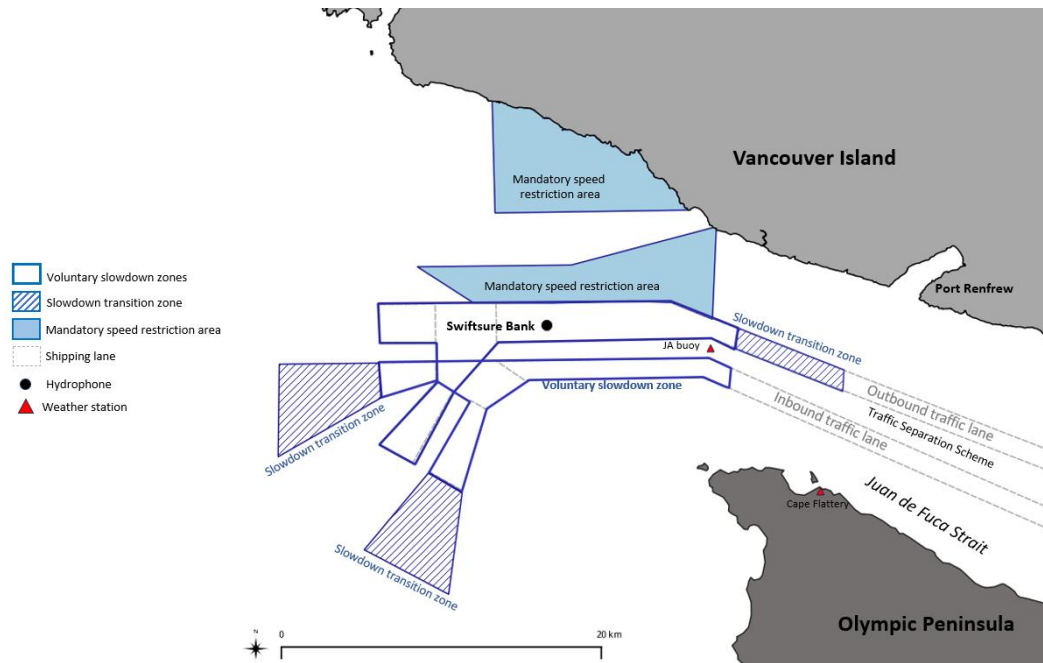


Figure 4: Slowdown measures on Swiftsure Bank (outlined in blue). The transition area is indicated with blue cross hatching, and the acoustic mooring shown with a black circle. 2022 was the first year where traffic was requested to slowdown in outbound and inbound shipping lanes and continued for 2023 and 2024.

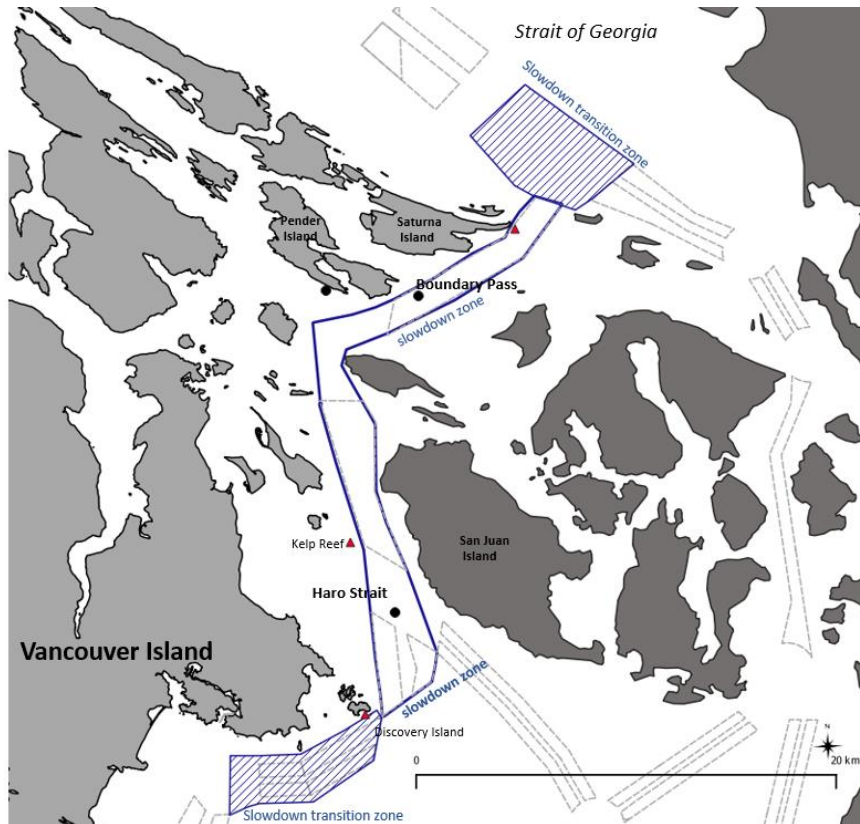


Figure 5: Slowdown measures in Boundary Pass and Haro Strait (outlined in blue). The transition area is indicated with blue cross hatching. The acoustic moorings shown with black circles and weather station in red triangles.

3.6 Lateral Displacement assessments

Lateral displacement was implemented from June 1st to October 31st for all 3 years (2022, 2023, 2024). All tugs and barges transiting the inshore waters of Juan de Fuca Strait were requested to change their transits to a more southerly route, away from SRKW foraging areas (Figure 6), if it was safe and operationally feasible to do so. These vessels were requested to move into a designated displacement zone, or into the outbound shipping lane (Figure 6). The displacement zone is a 1500 m wide corridor with a length of approximately 28 nm/ 52 km of the Strait (orange area, Figure 6). Tugs that were doing port-to-port transits were exempt from the request.

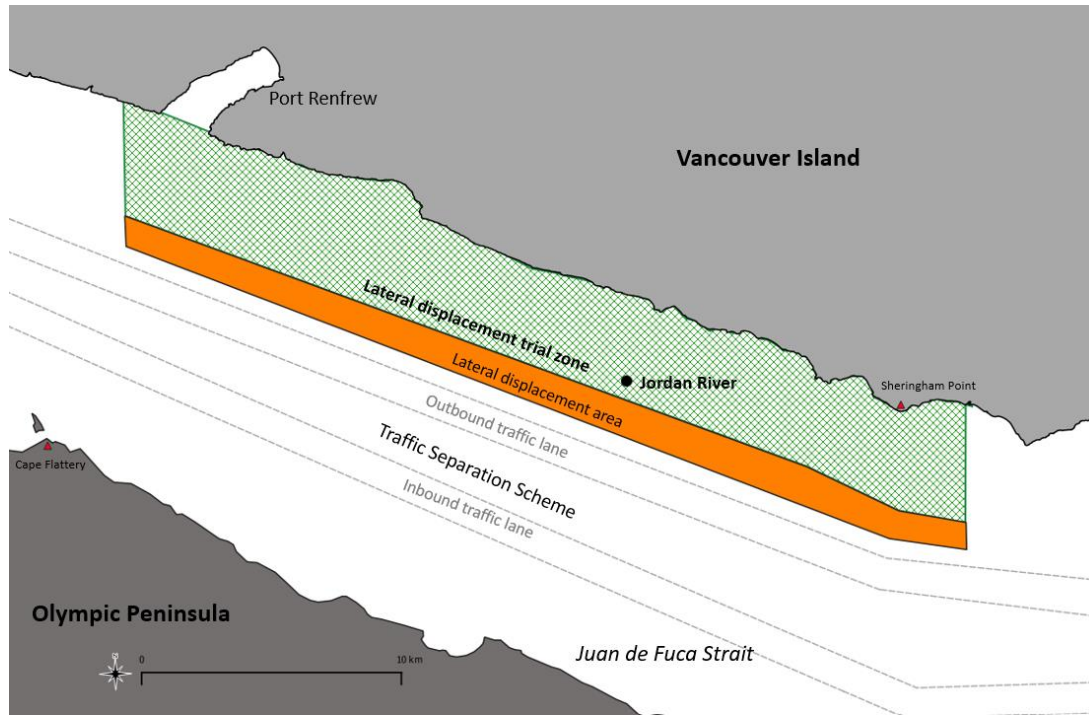


Figure 6: Lateral displacement measures in Juan de Fuca Strait. Tugs and barges are requested to move out of the lateral displacement trial zone (indicated in hatched green) into either the inshore lateral displacement zone (orange shading) or outbound shipping lane (grey outline). The acoustic mooring shown with black circle and weather station in red triangle.

For the 2022, 2023 and 2024 lateral displacement trials, participation was assessed by analyzing changes in the closest point of approach (CPA) and transit distance from the Jordan River acoustic mooring. Tug transits during the trial period were compared to those from the preceding months. The percentage of time spent at varying distances from the mooring, used as a proxy for proximity to coastal SRKW foraging areas, was calculated to evaluate changes in tug transit routes between the pre-trial and trial periods.

3.7 Interim Sanctuary Zones (ISZs)

For these analyses, only the ISZ located in Swanson Channel off Pender Island had a recorder deployed, and therefore, acoustic changes were evaluated in this location only. Compliance to ISZs in Swanson Channel and off East Point of Saturna Island was considered by visualising vessel track data from Class B AIS.

The vessel exclusion in Swanson Channel and East Point was implemented between June 1st and November 30th for all 3 years; 2022, 2023 and 2024 (Figure 7, Table 3). Acoustic comparisons were made for the control periods of 2 months prior and subsequent to the trial using recordings off Pender Island.

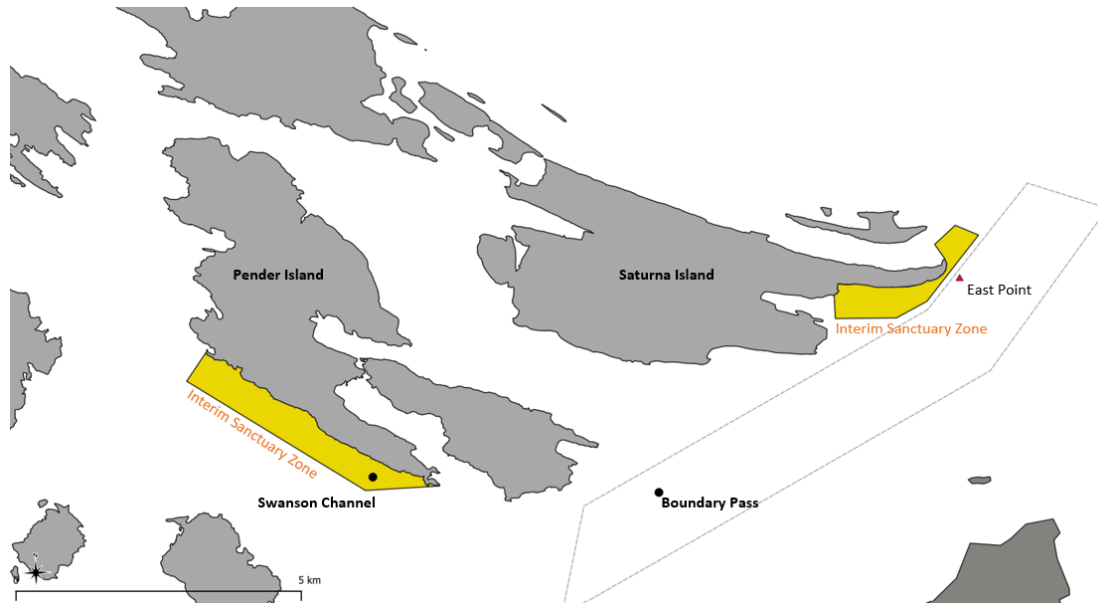


Figure 7: Swanson Channel and Saturna Island ISZs shown in yellow with moorings shown as black dots and weather stations as red triangles.

Table 3: Coordinates from Schedule 2 of the Interim Order that outline the Interim Sanctuary Zone at Swanson Channel and Saturna Island.

Interim Sanctuary Zone		
Swanson Channel:		
48.7361N, 123.23167W	to	
48.7361N, 123.259167W	to	
48.7675N, 123.32527W	to	
48.7675N, 123.306383W		
Saturna Island:		
48.78583N, 123.04555W	to	
48.78945N, 123.048583W	to	
48.793616N, 123.041383W	to	
48.791217N, 123.032917W	to	
48.775967N, 123.05245W	to	
48.772216N, 123.063416W	to	
48.7725N, 123.08583W	to	
48.77805N, 123.08583W		

4. RESULTS

4.1. Vessel slowdown assessments

4.1.1 Swiftsure Bank slowdown trial

The reported participation rates, as measured by the ECHO Program (reported by the BC Coast Pilots), were similar for 2022 to 2024. In 2022, when both inbound and outbound traffic were

included, participation was 82% (3,565 out of ~4,348 vessels). This slightly increased to 86% (3,636 out of 4,214 vessels) in 2023 and was recorded at 84% (3,332 out of 3,970 vessels) in 2024 (ECHO, 2023; ECHO, 2024). These numbers are comparable to the earlier years of the program when only outbound traffic was included. For comparison, participation rates were 82% in 2020 and 81% in 2021 (see Appendix Table 1), indicating sustained industry engagement in the voluntary initiative even with the expanded scope. For all 3 years the trial ran from June 1st until October 31st.

Bulk carriers were the most frequent vessel type transiting the Swiftsure Bank region across both pre- and post-trial, and trial periods. In contrast, vehicle carriers represented the smallest proportion of vessel passages among the analyzed commercial vessel types (Figure 8). The relative time each vessel type was the closest to the mooring, calculated over a 20 km radius using 5-minute intervals, remained largely consistent from the pre-trial period through to the active trial months. This suggests that the overall composition of vessel types and transit route in proximity to the mooring did not change significantly from control to trial periods.

Commercial vessel presence patterns showed expected seasonal trends. Passenger vessel activity increased notably during the summer months, consistent with the cruise ship season (Figure 8). Meanwhile, fishing vessel presence (Figure 8) increased in summer into the fall, corresponding with seasonal fisheries openings. Overall, there were no major shifts in the proportional presence of commercial vessel types between control and trial periods. This reinforces that the observed changes in vessel speed and soundscape changes were likely attributable to the slowdown trial rather than shifts in traffic composition.

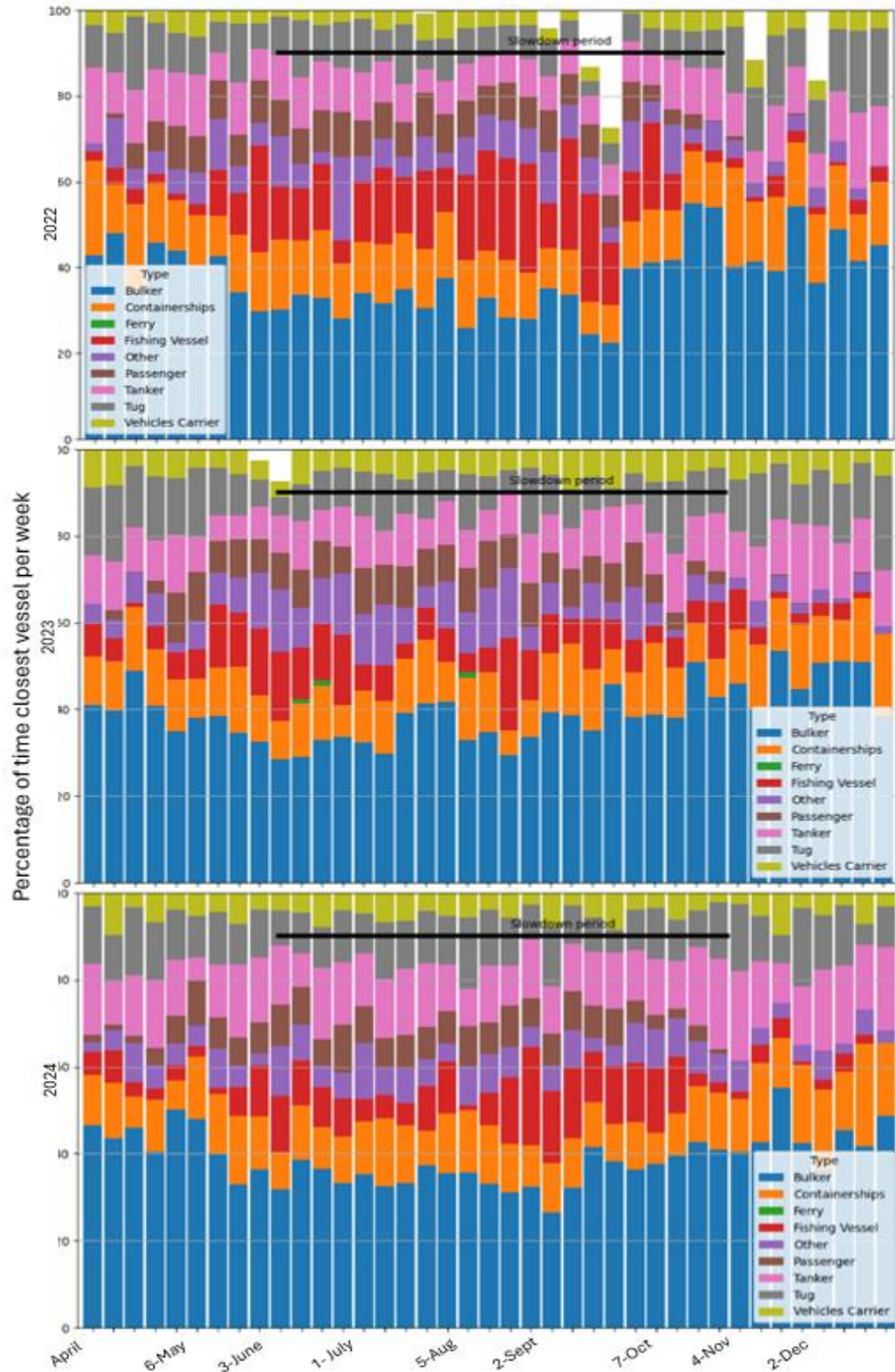


Figure 8: Swiftsure Bank proportional presence of vessel types established weekly using 5-minute data sections for pre-, during and post-trial periods. The trial began June 1st and finished October 31st for all three years: 2022 (top), 2023 (middle) and 2024 (bottom). 'Other' category includes recreational, government, and naval vessels, as well as any unknown vessels.

The speed of each commercial vessel transit was analyzed to evaluate participation in the slowdown trial. Speed over ground (SOG), calculated directly from AIS data, was used for this assessment (Figure 9a,b,c). Comparisons between SOG and speed through water (STW), which accounts for currents, showed minimal differences. However, both metrics indicated a clear reduction in vessel speeds during the trial period compared to the pre- and post-trial periods. Strong peaks in the data indicate that many vessels transited at or within 1 knot of the requested slowdown speed (Figures 9a,b,c). On average, bulk carriers reduced their speed by approximately 2 knots, while tankers slowed by about 3 knots from pre-trial levels to comply with the requested speed limit (table 4). For containerships and vehicle carriers, pre-trial speeds were multi-modal; a peak at approximately 14.5 knots, the requested slowdown speed, suggested that many of these vessels required little adjustment. A secondary peak at around 20 knots for containerships, and at over 20 knots for vehicle carriers, indicates that some vessels would have needed to reduce their speed by up to 10 knots during the trial phase to participate (Figures 9a,b,c). However, these large scale changes in speed applied to a small proportion of the vessels. Figures 9 a, b and c show that there was a substantial change in the vehicle carrier speed probability density distribution, but that this change was representative of ~5-10% of the vessels reducing their speed from approx. 20 knots to 14.5 knots. The remaining vessels showed little to no change in their speed, leading to an overall change in speed by 0.5 to 1 knot (Table 4). This may explain why the big changes seen in the vehicle carrier and container vessel speed was not seen to translate to large changes in SPL. Also, although many vessels participated in the trial and adhered to the speed request, some vessels were still seen to be travelling at speeds up to 20 knots during the trial period.

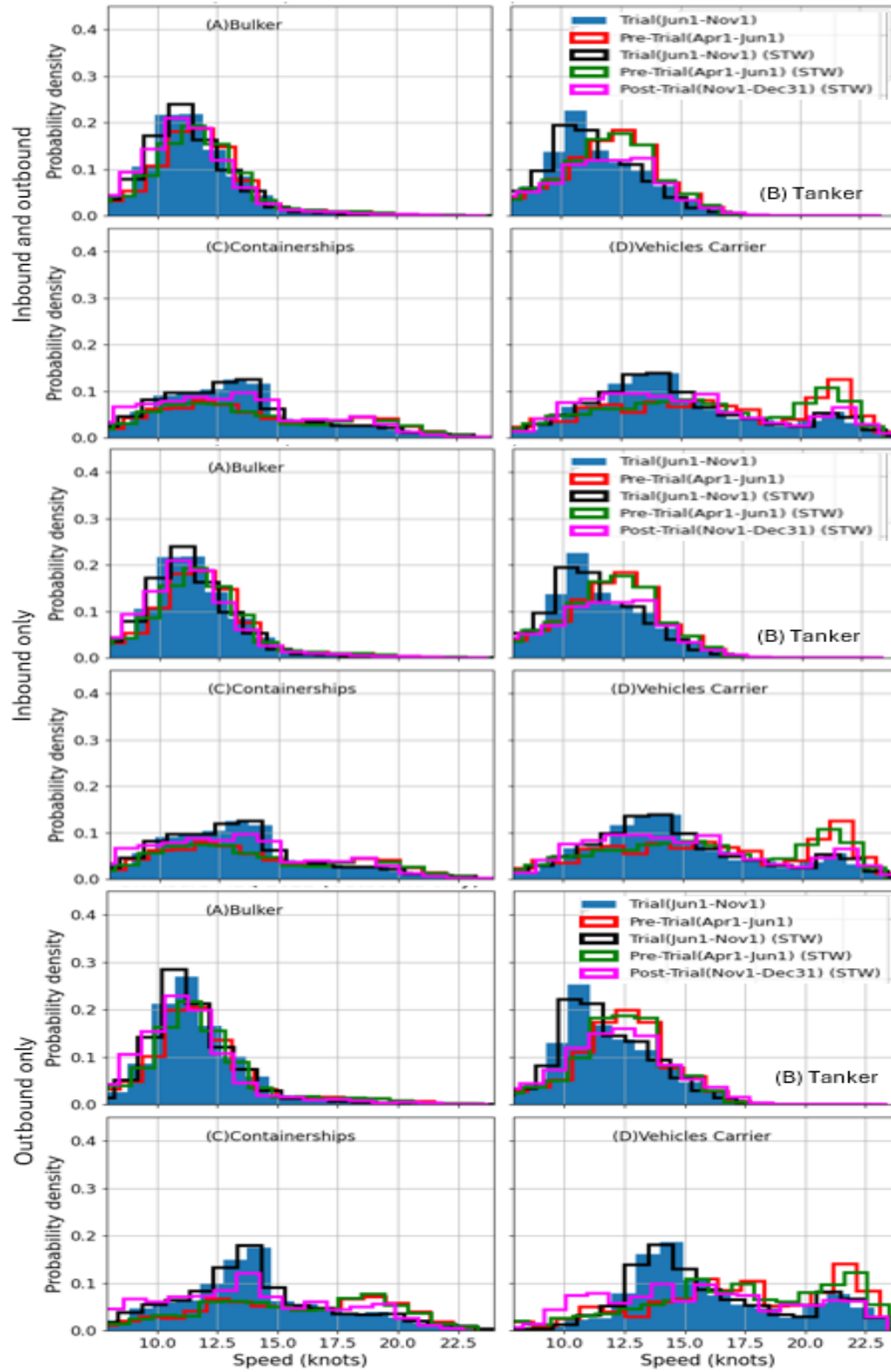


Figure 9a: Comparison of the speed over ground (SOG solid blue and red outline) and speed through water (STW black (trial), green (pre-trial) and pink (post-trial) outline) of bulkers (A), tankers (B), containerships (C), and vehicle carriers (D) at Swiftsure Bank in 2022. Showing: top - inbound and outbound traffic, middle - inbound traffic only and bottom - outbound traffic only.

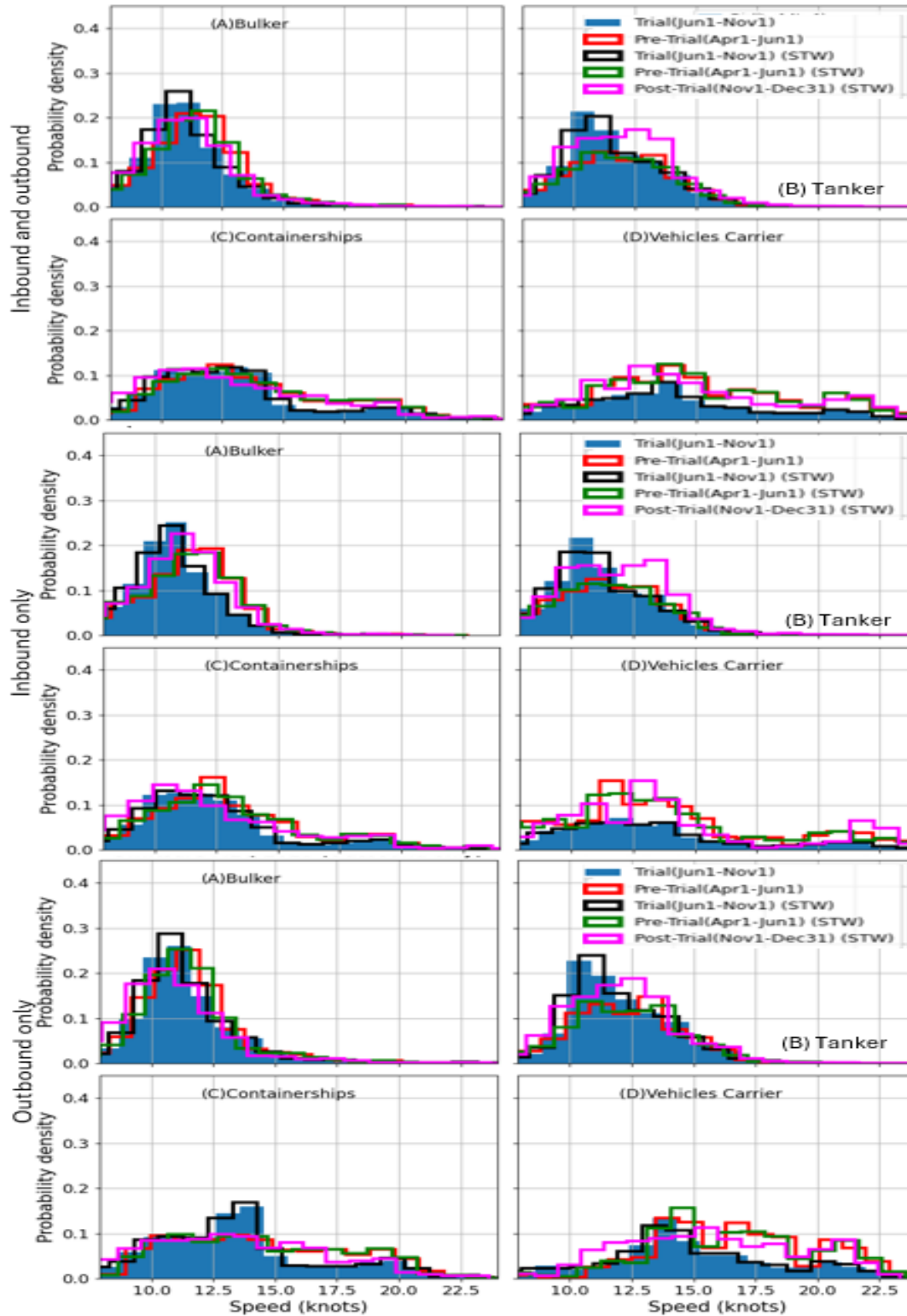


Figure 9b: Comparison of the speed over ground (SOG solid blue and red outline) and speed through water (STW black (trial), green (pre-trial), and pink (post-trial) outline) of bulkers (A), tankers (B), containerships (C), and vehicle carriers (D) at Swiftsure Bank in 2023. Showing: top - inbound and outbound traffic, middle - inbound traffic only and bottom - outbound traffic only.

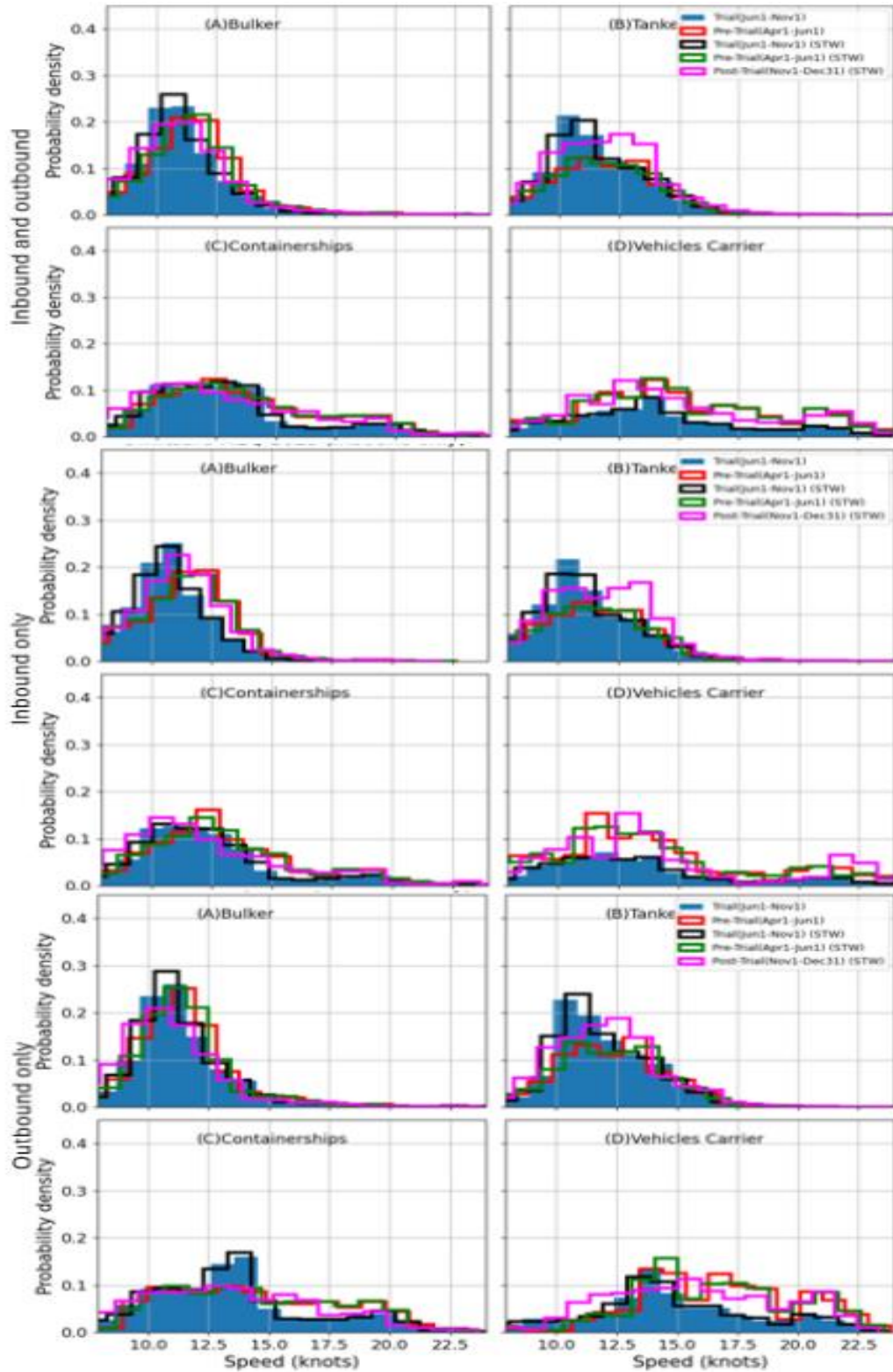


Figure 9c: Comparison of the speed over ground (SOG solid blue and red outline) and speed through water (STW black (trial), green (pre-trial), and pink (post-trial) outline) of bulkers (A), tankers (B), containerships (C), and vehicle carriers (D) at Swiftsure Bank in 2024. Showing: top - inbound and outbound traffic, middle - inbound traffic only and bottom - outbound traffic only.

Table 4: Speed over ground (SOG) and speed through water (STW) metrics in knots for pre-trial, trial and post-trial periods at Swiftsure Bank for inbound and outbound vessels transiting the slowdown area for 2022, 2023 and 2024. The raw AIS data presented in this table were obtained from Canadian Coast Guard terrestrial receivers. The dataset contains multiple instances of reported vessel speeds equal to zero; these values have been retained as originally received.

Metric	Bulkер			Tanker			Containership			Vehicle Carrier		
	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Speed over ground (knots)												
Pre-trial												
Minimum	0.0	0.0	0.4	0.2	0.0	0.2	0.0	0.1	0.4	0.1	0.2	0.2
Mean	10.2	10.7	11.2	11.2	8.6	11.4	9.4	12.2	13.4	15.4	14.5	13.7
Median	11.2	11.2	11.2	11.8	10.5	11.7	10.7	12.5	13.3	15.8	14.3	14.0
75th percentile	12.5	12.4	12.3	13.2	12.7	13.2	14.4	15.3	16.3	20.4	17.6	16.9
25th percentile	9.3	9.7	10.1	9.8	1.6	10.0	1.3	10.1	11.0	12.0	11.8	10.9
Maximum	23.7	24.1	23.2	23.3	24.5	24.2	23.9	24.8	24.2	24.1	24.1	24.4
Trial												
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Mean	10.5	10.2	10.6	10.2	10.4	10.3	11.1	10.6	12.1	14.5	7.8	12.5
Median	11.0	10.6	10.8	10.8	10.9	10.6	12.1	11.5	12.4	14.1	8.5	13.0
75th percentile	12.2	11.8	11.8	12.4	12.7	12.0	14.2	13.7	14.4	16.8	13.8	15.5
25th percentile	9.8	9.5	9.7	9.4	9.7	9.3	9.3	8.8	10.1	12.2	0.5	10.0
Maximum	24.8	24.2	23.6	23.1	24.7	24.7	24.5	24.2	24.9	24.9	24.0	24.2
Post-Trial												
Minimum	0.2	0.1	0.0	0.0	0.6	0.0	0.0	0.3	0.0	1.7	0.3	0.6
Mean	10.6	10.5	9.2	9.4	11.7	10.1	11.2	11.9	10.5	14.6	13.9	11.7
Median	11.0	10.7	10.0	10.8	11.8	10.5	11.8	11.7	10.6	14.1	13.6	11.6
75th percentile	12.3	11.9	11.4	12.9	13.2	12.2	14.6	14.6	13.9	17.3	16.8	15.5
25th percentile	9.5	9.3	7.6	6.5	10.2	8.4	8.6	9.4	7.1	11.5	10.9	7.2
Maximum	24.4	24.3	23.0	23.4	24.9	24.9	23.7	24.6	23.8	25.0	24.9	24.9

Speed through water (knots)**Pre-trial**

Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Mean	10.1	10.6	11.1	11.1	8.6	11.4	9.3	12.1	13.4	15.3	14.4	13.7
Median	11.1	11.1	11.2	11.7	10.4	11.7	10.6	12.5	13.3	15.5	14.2	14.0
75th percentile	12.5	12.3	12.3	13.1	12.6	13.2	14.4	15.3	16.2	20.0	17.5	16.8
25th percentile	9.2	9.7	10.1	9.6	1.6	10.0	1.2	10.1	11.0	12.0	11.6	10.8
Maximum	23.8	23.8	23.1	23.2	24.0	24.5	24.1	24.7	23.9	23.5	24.1	24.5

Trial

Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	10.4	10.1	10.5	10.0	10.4	10.2	11.0	10.5	12.1	14.4	7.7	12.4
Median	10.9	10.6	10.7	10.7	10.9	10.5	12.0	11.4	12.4	14.0	8.4	13.0
75th percentile	12.1	11.7	11.8	12.3	12.6	11.9	14.1	13.6	14.4	16.7	13.7	15.5
25th percentile	9.7	9.4	9.6	9.2	9.6	9.2	9.2	8.8	10.0	12.1	0.4	9.9
Maximum	24.6	24.2	23.1	22.7	24.7	25.1	24.2	24.2	24.7	24.6	24.2	24.2

Post-Trial

Minimum	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.1	0.0	1.2	0.3	0.0
Mean	10.5	10.5	9.1	9.3	11.7	10.0	11.1	11.9	10.4	14.5	13.9	11.7
Median	10.9	10.7	9.9	10.7	11.8	10.4	11.7	11.7	10.5	14.1	13.5	11.5
75th percentile	12.1	12.0	11.3	12.8	13.2	12.1	14.5	14.7	13.8	17.4	16.9	15.5
25th percentile	9.4	9.3	7.5	6.5	10.2	8.3	8.5	9.5	6.9	11.5	10.9	7.2
Maximum	23.7	24.7	22.8	23.4	24.7	24.9	24.0	24.6	24.0	25.2	25.2	25.1

To isolate the impact of the commercial vessel slowdown, environmental condition constraints were applied, and a small vessel detector was utilized to eliminate potential confounding noise sources. Table 5 shows the data segments that were excluded due to current speeds exceeding 0.3 ms^{-1} , wind speeds above 5 m s^{-1} and small vessel presence for pre-trial, trial and post-trial periods for 2022, 2023 and 2024.

Table 5: Data segments excluded due to current speeds exceeding 0.3 ms^{-1} , wind speeds above 5 m s^{-1} and small vessel presence for pre-trial, trial and post-trial periods for 2022, 2023 and 2024 for Swiftsure Bank. For each trial stage, the number of total records remaining after filtering, as well as percent of total number of records remaining, are included in the table.

	Current			Wind			Small Vessel		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-trial									
Total # records	87815	86873	131040	87815	86873	131040	87815	86873	131040
# of records excluded	14149	10724	11308	36815	33412	40590	4284	4913	7553
% excluded	16.1	12.3	8.6	41.9	38.5	31.0	4.9	5.7	5.8
Trial									
Total # records	214801	211234	177120	214801	211234	177120	214801	211234	177120
# of records excluded	38223	38103	23446	99276	43644	34346	19653	18909	16302
% excluded	17.8	18.0	13.2	46.2	20.7	19.4	9.1	9.0	9.2
Post-Trial									
Total # records	84915	87721	87840	84915	87721	87840	84915	87721	87840
# of records excluded	8046	15024	18166	23942	62643	68603	3294	4331	5097
% excluded	9.5	17.1	20.7	28.2	71.4	78.1	3.9	4.9	5.8
	2022	2023	2024						
Pre-trial									
# of records remaining	41466	44173	77810						
% remaining	47.2	50.8	59.4						
Trial									
# of records remaining	90896	126989	113308						
% remaining	42.3	60.1	64.0						
Post-Trial									
# of records remaining	53298	19333	14263						
% remaining	62.8	22.0	16.2						

SPL within the frequency bands corresponding to SRKW communication, echolocation, and vessel presence were analyzed before (Figure 10A) and after data filtering (Figure 10B) for

the pre-trial, trial, and post-trial periods. Minimal differences were observed in SPL levels for communication and echolocation frequencies between the pre-trial and trial periods; however, an increase in SPL was evident during the post-trial period in 2023 particularly (Figure 10, Table 6). In contrast, lower frequency ranges, particularly those below 100 Hz, exhibited greater variability across the periods, with SPL levels rising from pre-trial to trial and further increasing from trial to post-trial (Figure 10). A similar trend has been reported for previous years (see Burnham and Vagle, 2023).

Reduction in SPL between the pre-trial and post-trial to trial periods was not found to be consistent for any of the frequency ranges of interest (Table 6 and 7). The greatest changes between the control and trial periods were seen in the low to mid-frequencies.

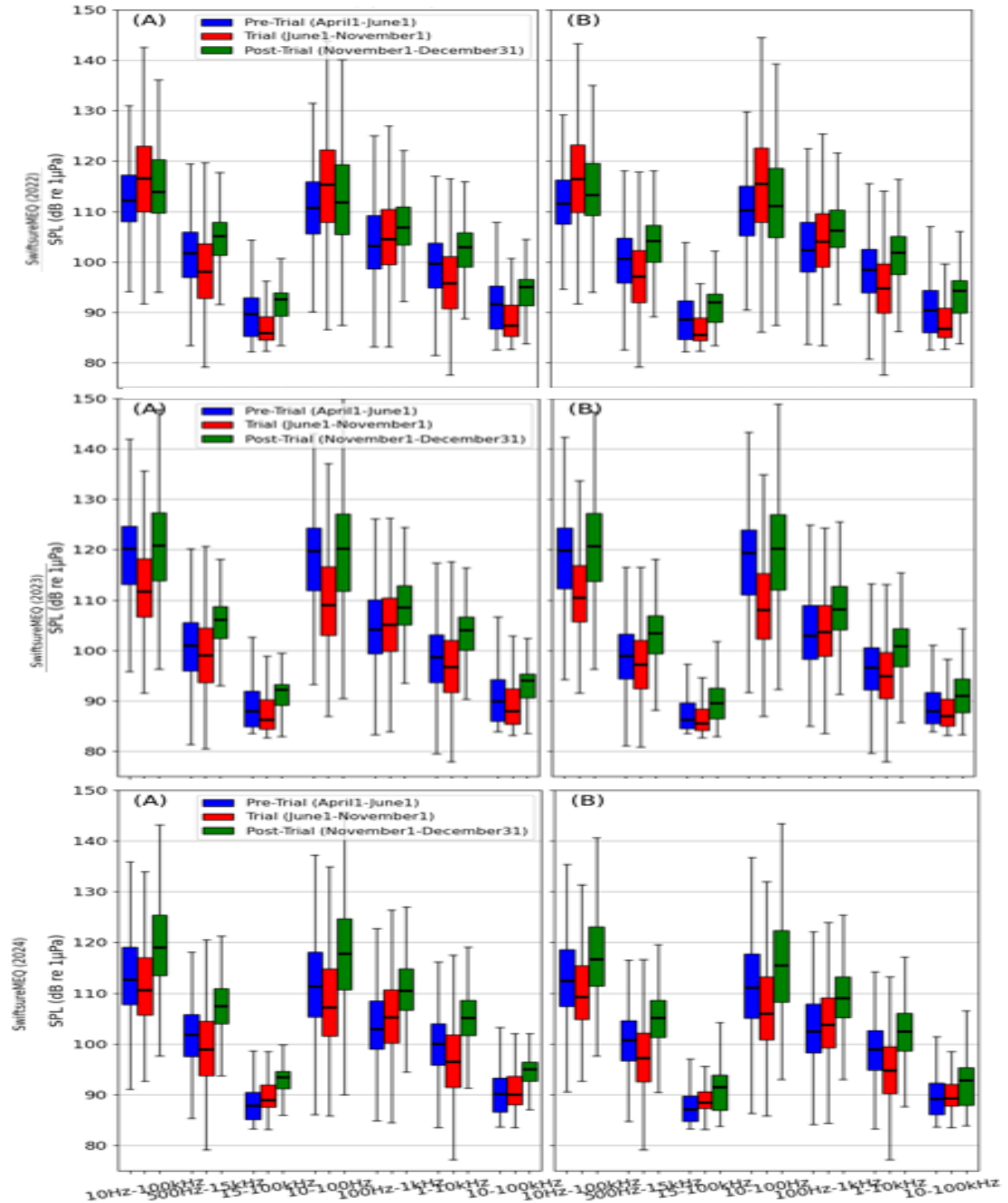


Figure 10: Sound pressure levels of the frequency ranges of interest at Swiftsure Bank as recorded (A) and with the environmental restrictions of current less than 0.3 ms^{-1} , windspeed less than 5 ms^{-1} , and small vessel signatures removed (B) for 2022 (top), 2023 (middle) and 2024 (bottom).

Table 6: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance, and vessel presence at Swiftsure Bank with and without the environmental restrictions (filters) of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} and small vessels removed from 2022 to 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Without Filters																					
Pre-trial																					
Minimum SPL	91.1	91.3	90.6	81.0	80.8	82.0	82.2	83.5	83.3	83.3	83.5	84.9	83.1	81.6	81.9	78.2	79.4	80.8	82.5	83.9	83.6
Mean SPL	127.1	127.7	126.8	113.2	113.9	114.1	110.6	108.9	103.0	126.2	127.0	126.2	118.7	118.9	118.0	110.3	111.0	111.1	110.8	109.3	104.0
Median SPL	112.1	120.2	112.7	101.6	100.9	101.7	89.6	87.9	87.8	110.7	119.6	111.2	103.1	104.1	102.9	99.6	98.6	100.0	91.5	89.8	90.1
75th percentile SPL	117.2	124.7	119.0	105.9	105.6	105.8	92.9	91.9	90.5	115.9	124.4	118.1	109.2	110.0	108.5	103.7	103.2	103.9	95.2	94.2	93.3
25th percentile SPL	108.0	113.1	107.8	96.9	95.9	97.6	85.2	84.8	85.1	105.6	111.9	105.3	98.6	99.3	99.0	94.8	93.6	95.8	86.7	85.9	86.6
Maximum SPL	161.0	161.9	161.0	144.5	151.2	154.4	154.8	153.9	143.7	160.9	161.7	160.9	150.4	149.8	154.8	139.9	149.4	142.5	154.8	153.9	143.7
Trial																					
Minimum SPL	91.7	91.6	92.6	79.1	80.5	79.1	82.3	82.7	83.2	82.7	86.9	85.9	83.2	82.2	81.6	77.6	78.0	77.2	82.6	83.1	83.6
Mean SPL	126.3	125.6	126.0	112.6	112.6	113.8	105.7	102.6	105.3	125.4	124.8	125.1	118.4	117.6	118.4	109.4	109.7	110.7	106.3	103.4	106.3
Median SPL	116.5	111.7	110.6	98.0	99.0	98.9	85.8	86.2	88.9	115.3	109.0	107.1	104.5	105.0	105.1	95.7	96.7	96.4	87.3	87.9	90.0
75th percentile SPL	123.0	118.2	117.0	103.6	104.4	104.4	89.2	90.2	91.9	122.3	116.7	114.9	110.5	110.4	110.6	101.0	102.0	101.8	91.4	92.4	93.6
25th percentile SPL	110.0	106.6	105.6	92.8	93.6	93.7	84.5	84.4	87.5	107.9	103.0	101.5	99.4	99.8	100.2	90.7	91.6	91.4	85.2	85.4	88.1
Maximum SPL	162.3	161.6	162.2	147.3	147.1	151.2	152.9	146.2	150.2	162.1	161.5	161.6	155.4	152.6	157.7	142.8	143.7	148.3	152.9	146.2	150.2
Post-trial																					
Minimum SPL	94.0	96.3	97.6	81.4	81.2	80.8	83.4	83.0	83.7	87.4	90.5	89.1	86.3	89.2	86.9	79.1	79.4	78.6	83.8	83.3	83.9
Mean SPL	127.9	130.4	133.5	114.3	114.5	115.8	100.0	108.4	102.0	127.4	130.1	133.2	118.3	118.6	120.8	109.7	111.8	113.7	101.9	108.7	103.1
Median SPL	113.8	120.8	118.9	105.1	106.0	107.4	92.5	92.1	93.4	111.8	120.2	117.8	106.8	108.5	110.4	102.8	103.9	105.0	95.0	94.0	94.9
75th percentile SPL	120.3	127.4	125.4	107.9	108.7	110.9	93.8	93.3	94.7	119.3	127.1	124.7	110.9	112.8	114.8	105.8	106.6	108.6	96.6	95.3	96.4
25th percentile SPL	109.7	113.8	113.5	101.3	102.4	104.0	89.2	89.1	91.2	105.4	111.8	110.7	103.4	105.1	106.7	98.9	100.1	101.7	91.3	90.6	92.6
Maximum SPL	160.1	162.6	161.2	157.4	153.3	148.9	138.0	156.7	140.7	160.0	162.5	161.1	157.4	156.3	151.1	141.1	150.6	148.9	138.0	156.7	140.7

With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessel filter**Pre-trial**

Minimum SPL	91.1	91.6	90.6	81.0	80.8	82.0	82.2	83.5	83.3	83.3	83.5	84.9	83.7	85.0	81.9	78.2	79.4	80.9	82.5	83.9	83.6
Mean SPL	122.5	124.5	123.4	109.5	108.9	109.1	106.5	92.5	92.5	121.5	124.0	122.8	115.2	115.1	114.4	106.5	105.8	106.8	106.7	94.7	95.0
Median SPL	111.5	119.8	112.4	100.6	98.9	100.7	88.5	86.2	87.1	110.1	119.3	111.0	102.3	102.9	102.4	98.4	96.5	98.9	90.3	87.9	89.2
75th percentile SPL	116.2	124.3	118.6	104.7	103.2	104.6	92.3	89.6	89.7	115.0	124.0	117.8	107.8	108.9	107.8	102.5	100.6	102.6	94.4	91.7	92.2
25th percentile SPL	107.5	112.3	107.4	95.9	94.3	96.7	84.6	84.5	84.8	105.2	111.1	105.1	98.0	98.3	98.3	93.8	92.2	94.9	85.9	85.4	86.1
Maximum SPL	152.3	147.4	153.3	137.2	139.2	136.9	145.0	121.5	118.0	152.2	147.3	152.8	142.8	145.7	143.4	130.7	139.1	132.9	145.0	121.5	121.1

Trial

Minimum SPL	91.7	91.6	92.6	79.1	80.8	79.1	82.3	82.7	83.2	82.7	86.9	85.9	83.2	82.2	82.1	77.6	78.0	77.2	82.6	83.1	83.6
Mean SPL	124.3	123.0	122.6	108.4	108.0	109.4	92.7	92.7	96.0	123.8	122.4	121.6	115.4	114.5	116.0	105.0	105.4	106.7	94.8	94.7	99.3
Median SPL	116.4	110.5	109.2	97.0	97.1	97.2	85.5	85.5	88.4	115.4	107.9	105.9	104.0	103.6	103.7	94.7	94.8	94.7	86.7	86.9	89.3
75th percentile SPL	123.2	116.9	115.4	102.3	102.1	102.1	88.9	88.3	90.6	122.7	115.4	113.3	109.6	109.0	109.1	99.5	99.5	99.4	90.8	90.3	92.1
25th percentile SPL	109.9	105.7	104.8	91.9	92.5	92.5	84.3	84.1	87.3	107.9	102.3	100.8	99.0	98.8	99.2	89.9	90.5	90.2	84.9	85.0	87.8
Maximum SPL	153.2	147.9	162.2	139.7	136.1	148.6	118.7	124.2	135.2	153.1	147.1	160.4	144.8	147.8	157.7	133.0	133.9	147.1	127.6	126.4	140.8

Post-trial

Minimum SPL	94.0	96.3	97.6	81.4	82.7	80.8	83.4	83.0	83.7	87.4	92.3	93.0	86.3	89.2	86.9	79.1	80.6	78.6	83.8	83.3	83.9
Mean SPL	124.9	129.4	131.2	109.5	110.5	112.4	95.1	95.0	96.5	124.4	129.1	130.9	115.2	116.5	118.6	106.9	108.1	109.7	97.5	96.5	97.9
Median SPL	113.2	120.7	116.6	104.2	103.4	105.0	91.9	89.5	91.5	111.0	120.1	115.4	106.2	108.1	109.0	101.8	100.8	102.4	94.2	91.0	92.7
75th percentile SPL	119.5	127.2	123.1	107.2	106.9	108.7	93.7	92.6	93.9	118.6	126.9	122.3	110.4	112.7	113.3	105.0	104.3	106.0	96.3	94.3	95.4
25th percentile SPL	109.2	113.7	111.4	100.0	99.4	101.4	88.0	86.5	86.9	104.8	112.0	108.2	102.8	104.1	105.2	97.5	96.8	98.7	89.9	87.7	87.9
Maximum SPL	155.1	150.9	155.6	134.0	139.4	135.2	120.3	120.3	117.9	154.9	150.5	155.6	143.7	139.9	139.6	130.9	139.4	130.6	121.8	121.7	119.6

Table 7: The difference in sound pressure levels in decibels (dB re 1 μ Pa) between pre-trial and trial, and trial and post-trial periods of the frequency ranges of SRKW relevance and vessel presence at Swiftsure Bank with the environmental restrictions of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} and small vessels removed from 2022 to 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-Trial to Trial																					
Minimum SPL	0.6	0.0	2.0	-1.9	0.0	-2.9	0.1	-0.8	-0.1	-0.6	3.4	1.0	-0.5	-2.8	0.2	-0.6	-1.4	-3.7	0.1	-0.8	0.0
Mean SPL	1.8	-1.5	-0.8	-1.1	-0.9	0.3	-13.8	0.2	3.5	2.3	-1.6	-1.2	0.2	-0.6	1.6	-1.5	-0.4	-0.1	-11.9	0.0	4.3
Median SPL	4.9	-9.3	-3.2	-3.6	-1.8	-3.5	-3.0	-0.7	1.3	5.3	-11.4	-5.1	1.7	0.7	1.3	-3.7	-1.7	-4.2	-3.6	-1.0	0.1
75th percentile SPL	7.0	-7.4	-3.2	-2.4	-1.1	-2.5	-3.4	-1.3	0.9	7.7	-8.6	-4.5	1.8	0.1	1.3	-3.0	-1.1	-3.2	-3.6	-1.4	-0.1
25th percentile SPL	2.4	-6.6	-2.6	-4.0	-1.8	-4.2	-0.3	-0.4	2.5	2.7	-8.8	-4.3	1.0	0.5	0.9	-3.9	-1.7	-4.7	-1.0	-0.4	1.7
Maximum SPL	0.9	0.5	8.9	2.5	-3.1	11.7	-26.3	2.7	17.2	0.9	-0.2	7.6	2.0	2.1	14.3	2.3	-5.2	14.2	-17.4	4.9	19.7
Trial to Post-Trial																					
Minimum SPL	2.3	4.7	5.0	2.3	1.9	1.7	1.1	0.3	0.5	4.7	5.4	7.1	3.1	7.0	4.8	1.5	2.6	1.4	1.2	0.2	0.3
Mean SPL	0.6	6.4	8.6	1.1	2.5	3.0	2.4	2.3	0.5	0.6	6.7	9.3	-0.2	2.0	2.6	1.9	2.7	3.0	2.7	1.8	-1.4
Median SPL	-3.2	10.2	7.4	7.2	6.3	7.8	6.4	4.0	3.1	-4.4	12.2	9.5	2.2	4.5	5.3	7.1	6.0	7.7	7.5	4.1	3.4
75th percentile SPL	-3.7	10.3	7.7	4.9	4.8	6.6	4.8	4.3	3.3	-4.1	11.5	9.0	0.8	3.7	4.2	5.5	4.8	6.6	5.5	4.0	3.3
25th percentile SPL	-0.7	8.0	6.6	8.1	6.9	8.9	3.7	2.4	-0.4	-3.1	9.7	7.4	3.8	5.3	6.0	7.6	6.3	8.5	5.0	2.7	0.1
Maximum SPL	1.9	3.0	-6.6	-5.7	3.3	-13.4	1.6	-3.9	-17.3	1.8	3.4	-4.8	-1.1	-7.9	-18.1	-2.1	5.5	-16.5	-5.8	-4.7	-21.2

The quantity of 5-minute AIS records within a 30 km radius of the Swiftsure Bank mooring was categorized by vessel type (Figure 11). Analysis revealed a near-linear increase in detections of AIS Class A vessels commencing in April, which corresponds to the onset of the pre-trial control period, and continuing through to the conclusion of the trial. The most notable variation between periods was observed in fishing vessels (Figure 11), whose presence significantly increased during the latter stages of the trial, coinciding with fisheries openings. Furthermore, the minimum distances at which fishing vessels passed the mooring generally decreased over the trial duration, with fishing vessels exhibiting the most substantial reduction in proximity (Figure 12). Increases in broadband noise levels, predominantly from the lower frequencies, through the trial period could be attributed to the increase in fishing vessels, and their closer passing distances. While all vessels are encouraged to be part of the trial, fishing vessels are not part of the focal vessel types for the slowdown request. The increases in the lower frequencies do not appear to impact the SRKW-relevant frequency ranges.

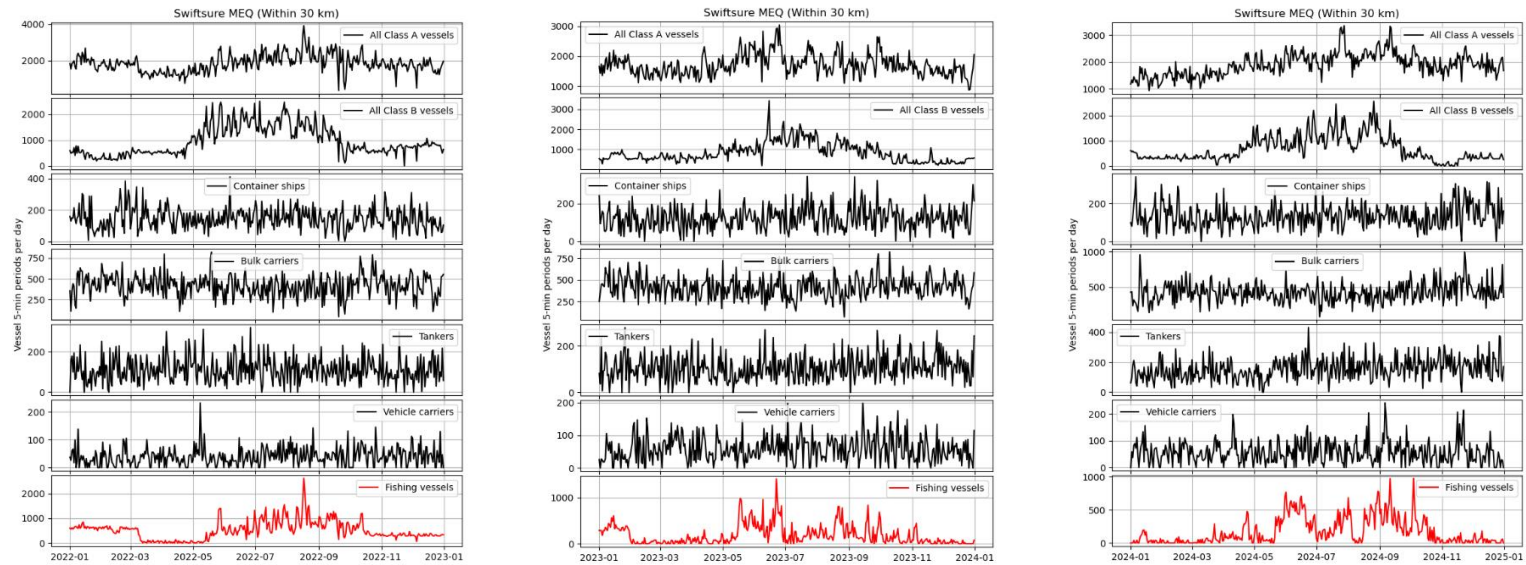


Figure 11: Number of 5-minute AIS data segments that have vessels present within 30 km from the Swiftsure Bank mooring by vessel type for 2022 (left), 2023 (centre) and 2024 (right). Fishing vessels are highlighted in red as they are thought to be the driver of the overall trend in vessel presence at Swiftsure Bank.

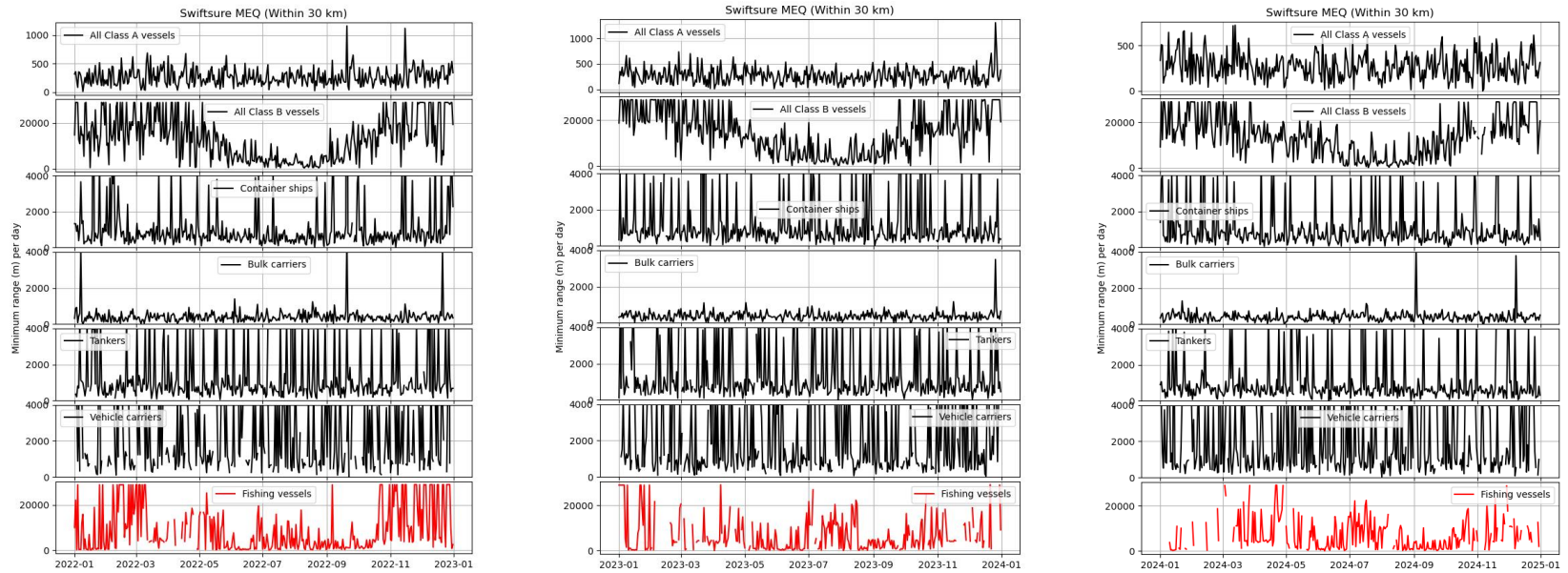


Figure 12: Range of vessels passing the Swiftsure Bank mooring at the closest point of approach for the pre-, post- and trial period. Records shown by vessel type for 2022 (left), 2023 (centre) and 2024 (right). Fishing vessels are highlighted in red as they are thought to be the driver of the overall trend in vessel presence at Swiftsure Bank.

Sound level measurements during periods when bulk carriers, tankers, containerships, or vehicle carriers were the vessels closest to the mooring exhibited comparable levels across these vessel types in both the control and trial periods (Figure 13, Table 8). The consistency in the overall sound field (Figure 10) and the acoustic comparisons by vessel type (Figure 13, Table 8) indicates that these commercial vessel classes are the primary contributors to the sound field level. Differences in sound levels expected from the slowdown were not seen, potentially due to the lack of speed adjustment needed by most vessels to be deemed as participating in the trial. Many of the containerships and vehicle carriers were already traveling at or within a knot of the requested slowdown speed, therefore, without substantial changes in speed or proximity to the recorder a significant change in SPL would not be expected. The Swiftsure Bank slowdown, more so than the Haro Strait-Boundary Pass slowdown, is influenced by more distant noise sources like remote vessels and offshore wind, which may not be fully accounted for during the filtering process. Overall increases were seen in broadband levels from trial periods when bulkers, tankers, containerships, and vehicle carriers were passing the mooring (Table 8).

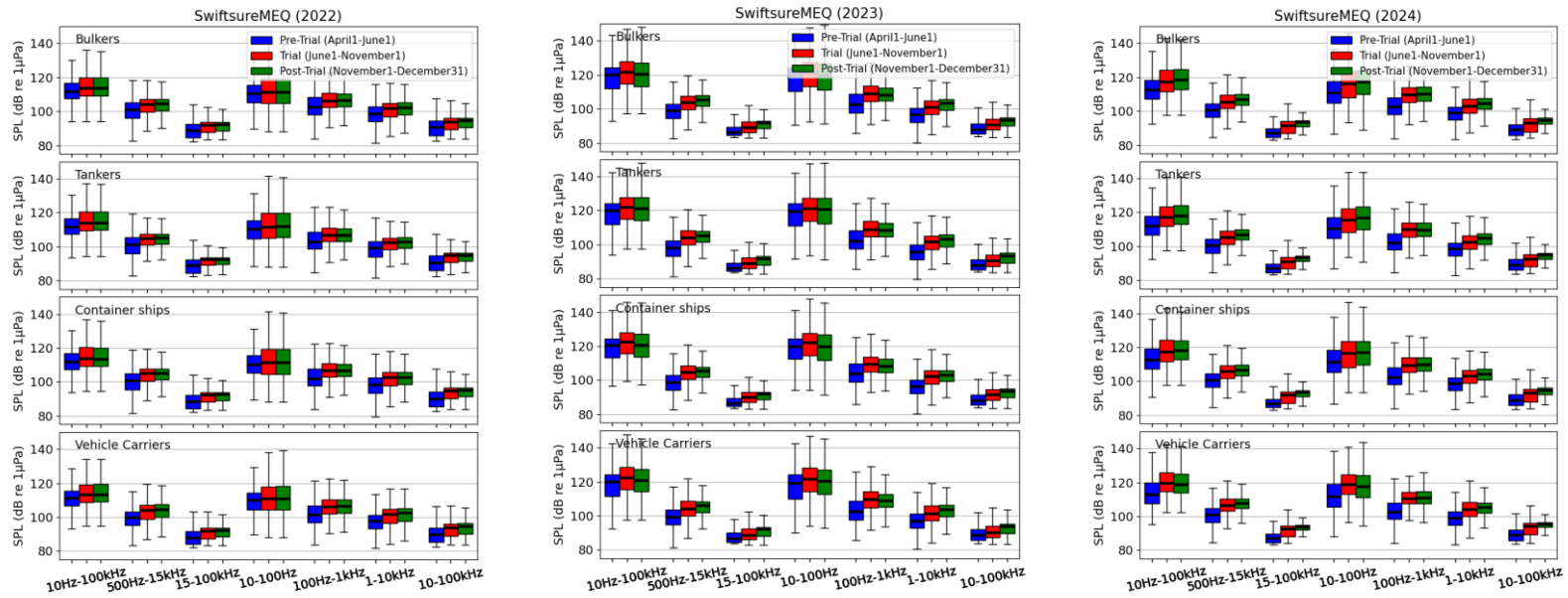


Figure 13: Sound pressure levels (dB re 1µPa) of the frequency ranges of interest at Swiftsure Bank comparing the pre-trial control (blue), trial periods (red) and post-trial (green) for Bulkiers, Tankers, Containerships, and Vehicle carriers for the broadband ambient noise (10 Hz to 100 kHz), SRKW communication (500Hz -15 kHz) and echolocation (15-100 kHz) and decadal bands for years 2022 (left), 2023 (centre) and 2024 (right).

Table 8: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance and vessel presence at Swiftsure Bank for periods when only bulkers, tankers, containership and vehicle carrier were present from 2022 to 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessel filter																					
Bulker																					
Pre-trial																					
Minimum	91.1	91.8	90.6	81.4	81.5	82.0	82.3	83.6	83.3	83.7	86.8	85.4	83.9	85.8	81.9	78.2	79.8	80.9	82.6	83.9	83.6
Mean	122.1	124.4	123.3	109.9	108.4	109.8	102.9	92.1	92.4	121.1	123.8	122.6	115.3	115.5	114.9	106.8	105.7	107.3	103.2	94.5	94.9
Median	111.8	119.9	112.3	100.8	98.9	100.7	88.7	86.2	86.9	110.5	119.4	111.0	102.6	102.6	102.4	98.7	96.5	99.0	90.5	87.8	89.0
75th percentile	116.8	124.5	118.6	105.1	103.1	104.7	92.6	89.6	89.6	115.6	124.3	117.6	108.4	108.8	108.0	102.9	100.4	102.7	94.6	91.6	92.2
25th percentile	107.8	111.9	107.4	96.1	94.5	96.7	84.8	84.5	84.6	105.3	110.6	105.0	98.3	97.9	98.3	94.1	92.3	94.9	86.0	85.4	85.9
Maximum	146.6	145.9	150.9	137.2	134.8	136.9	143.5	116.2	113.8	145.9	144.6	150.3	142.9	145.7	141.9	129.4	134.8	131.0	143.5	119.5	116.1
Trial																					
Minimum	94.4	97.5	97.6	81.5	83.4	86.2	83.4	83.0	83.9	88.1	92.7	93.5	86.3	89.2	88.3	79.2	80.8	82.8	83.8	83.4	84.1
Mean	128.2	130.9	133.3	112.2	115.5	116.7	99.8	101.6	105.3	127.8	130.6	133.0	117.6	118.7	121.1	109.6	113.8	114.5	101.7	102.9	106.4
Median	113.5	121.6	117.1	104.0	103.5	105.5	91.7	89.2	91.6	111.3	121.1	115.9	106.3	108.9	109.5	101.6	101.0	103.1	93.9	90.7	92.9
75th percentile	120.1	127.7	124.2	107.3	107.6	109.7	93.6	92.7	94.1	119.2	127.5	123.4	110.7	113.7	113.9	105.1	105.0	107.1	96.3	94.3	95.7
25th percentile	109.3	114.7	111.5	99.8	99.6	101.7	87.7	86.4	87.0	104.9	113.1	108.3	102.7	104.5	105.2	97.2	97.0	99.1	89.5	87.7	88.0
Maximum	160.1	154.9	159.8	140.3	142.3	143.1	129.8	131.1	134.6	160.0	154.9	159.7	145.5	143.5	143.2	137.9	142.3	140.9	131.3	132.3	135.6
Post-trial																					
Minimum	94.4	97.5	97.6	81.5	81.2	86.2	83.4	83.0	83.8	88.1	91.4	89.1	86.3	89.2	87.9	79.2	79.9	82.8	83.8	83.4	84.0
Mean	125.5	129.2	132.3	110.1	110.3	113.1	95.0	94.8	96.9	125.0	129.0	132.1	115.2	116.4	119.6	107.5	107.9	110.6	97.4	96.6	98.5
Median	113.5	120.2	118.3	104.4	105.3	106.8	92.2	91.9	93.3	111.2	119.5	117.0	106.4	108.1	110.0	102.1	103.1	104.5	94.6	93.6	94.8
75th percentile	119.9	127.2	124.6	107.4	107.9	110.1	93.7	93.2	94.5	119.0	126.9	123.9	110.4	112.4	114.3	105.2	105.9	107.7	96.3	95.1	96.1
25th percentile	109.5	113.3	113.0	100.6	101.7	103.7	88.7	88.7	91.2	105.0	111.2	110.0	102.9	104.7	106.3	98.0	99.4	101.2	90.6	90.1	92.6
Maximum	151.0	151.1	154.8	136.4	139.3	135.9	120.2	120.8	118.4	151.0	151.1	154.7	145.5	142.3	145.5	130.6	134.4	131.6	120.9	122.7	119.6

Tanker**Pre-trial**

Minimum	91.1	91.8	92.5	82.7	81.5	83.8	82.3	83.6	83.3	83.5	86.8	86.8	84.8	85.8	84.5	81.7	79.8	81.6	82.7	83.9	83.6
Mean	122.9	124.1	123.5	110.6	107.6	110.3	95.0	91.7	93.2	121.8	123.5	122.6	116.4	115.2	115.8	107.1	104.6	107.7	96.8	94.1	95.6
Median	111.6	119.9	111.8	101.2	98.2	100.3	88.7	86.1	86.8	110.1	119.4	110.3	102.8	102.1	101.9	99.1	95.6	98.3	90.6	87.7	88.9
75th percentile	116.7	124.1	118.0	105.5	102.4	104.1	92.4	89.4	89.8	115.3	124.0	117.0	108.7	108.3	107.6	103.2	99.9	102.1	94.6	91.3	92.3
25th percentile	107.5	111.9	106.9	96.1	93.4	96.2	84.7	84.5	84.6	104.5	111.0	104.5	98.7	97.7	97.8	94.0	91.2	94.4	85.9	85.4	85.9
Maximum	146.6	142.3	150.9	137.2	127.4	136.9	121.4	113.9	115.4	145.7	142.0	150.3	142.9	138.9	141.9	127.3	124.3	131.0	121.4	115.4	117.8

Trial

Minimum	94.4	97.5	97.6	81.5	84.6	81.3	83.4	83.1	83.8	88.1	93.5	93.5	86.3	91.1	88.3	79.2	82.4	79.1	83.8	83.5	84.0
Mean	128.6	130.9	130.9	112.5	115.2	116.1	100.1	99.2	104.7	128.3	130.6	130.5	117.8	118.6	120.8	109.8	113.7	113.6	102.1	100.6	105.7
Median	113.9	121.7	116.8	104.6	103.8	104.9	92.3	88.9	91.0	111.6	121.2	115.3	106.6	108.7	109.8	102.3	101.4	102.2	94.7	90.5	92.3
75th percentile	120.7	127.6	123.4	107.4	108.1	109.1	93.7	92.3	93.6	119.7	127.4	122.3	111.1	113.8	113.9	105.2	105.2	106.1	96.3	94.0	95.1
25th percentile	109.5	115.1	111.7	101.0	99.8	101.2	89.1	86.1	87.0	105.2	113.9	108.1	102.9	104.6	105.7	98.5	97.3	98.4	91.0	87.4	88.1
Maximum	160.1	154.9	159.8	139.7	142.3	143.1	129.8	123.1	134.6	160.0	154.9	159.7	145.5	141.6	143.2	136.1	142.3	140.9	131.3	124.3	135.6

Post-trial

Minimum	94.4	97.5	97.6	81.5	81.2	81.3	83.4	83.1	83.8	88.1	91.4	89.1	86.3	90.5	87.9	79.2	79.9	79.1	83.8	83.5	84.0
Mean	125.9	129.1	131.6	110.6	110.1	112.9	95.3	94.2	96.4	125.5	128.9	131.4	115.3	116.1	119.1	108.0	107.8	110.4	97.8	96.0	98.0
Median	113.9	121.1	117.9	105.0	105.2	106.8	92.5	91.5	93.4	111.7	120.6	116.7	106.8	108.2	109.5	102.7	103.0	104.6	94.9	93.2	94.9
75th percentile	120.7	127.6	124.0	107.6	107.9	109.8	93.7	93.0	94.5	119.8	127.4	123.3	110.7	112.4	113.7	105.4	105.8	107.5	96.3	95.0	96.1
25th percentile	109.8	114.1	112.9	101.6	101.5	103.7	89.7	88.0	91.3	105.4	112.4	109.8	103.3	104.7	106.1	99.3	99.0	101.3	91.7	89.2	92.6
Maximum	151.0	148.0	152.8	133.3	133.2	135.9	119.2	116.8	117.0	151.0	147.8	152.8	137.1	137.2	142.5	130.5	128.5	131.3	120.9	117.5	118.7

Containership**Pre-trial**

Minimum	91.1	91.8	90.6	81.4	81.5	82.0	82.3	83.6	83.3	83.5	86.9	85.4	83.9	85.8	82.2	78.2	79.8	80.9	82.6	83.9	83.6
Mean	121.9	124.8	123.0	109.4	108.1	109.5	105.4	91.8	92.5	120.8	124.3	122.3	115.1	114.8	114.5	106.4	105.1	107.2	105.6	94.2	95.0
Median	111.6	120.3	112.3	100.4	98.8	100.5	88.2	86.2	86.7	110.3	119.8	111.1	102.0	103.6	102.3	98.3	96.1	98.7	90.0	87.8	88.9
75th percentile	116.6	124.5	119.2	104.7	102.9	104.3	92.3	89.4	89.6	115.5	124.3	118.3	107.8	109.5	108.1	102.5	100.3	102.3	94.3	91.4	92.2

25th percentile	107.5	113.4	107.5	95.3	94.4	96.5	84.2	84.5	84.7	105.1	112.3	105.3	98.0	99.0	98.2	93.3	92.2	94.7	85.4	85.4	85.9
Maximum	143.7	147.4	141.6	137.2	129.1	131.5	143.5	114.6	113.8	143.6	147.3	141.3	142.1	137.5	136.9	127.8	124.2	129.9	143.5	116.7	116.1
Trial																					
Minimum	94.6	99.3	97.6	83.9	84.6	84.7	83.4	83.2	83.8	88.1	92.7	93.5	86.3	91.1	88.3	80.1	82.4	79.9	83.8	83.6	84.0
Mean	127.4	130.3	132.6	111.9	115.1	116.1	99.5	99.1	104.9	127.0	130.0	132.3	116.7	118.1	120.5	109.5	113.9	113.5	101.5	100.5	106.0
Median	113.5	122.4	117.3	104.8	104.5	105.7	92.2	90.0	91.9	111.2	121.9	116.4	106.6	109.1	109.4	102.4	102.0	103.1	94.6	91.6	93.1
75th percentile	120.2	127.9	124.2	107.9	108.5	109.5	93.8	93.0	93.9	119.2	127.7	123.7	111.0	113.8	113.9	105.8	105.8	106.7	96.5	94.8	95.6
25th percentile	109.2	115.7	111.5	100.4	100.4	101.7	88.3	87.1	87.0	104.5	114.3	108.2	103.1	105.0	105.3	97.6	97.7	99.1	90.2	88.4	87.9
Maximum	160.1	154.9	159.8	139.2	142.3	143.1	126.7	127.1	134.6	160.0	154.9	159.7	141.8	141.6	143.2	136.1	142.3	140.9	128.2	128.2	135.6
Post-trial																					
Minimum	94.6	97.5	97.6	83.9	81.2	84.7	83.4	83.2	83.8	88.1	91.4	93.5	86.3	91.1	87.9	80.1	79.9	79.9	83.8	83.6	84.0
Mean	125.4	128.7	130.8	110.6	110.3	113.0	95.5	94.8	97.0	124.9	128.4	130.5	115.3	116.2	119.0	107.6	107.8	110.5	98.0	96.6	98.6
Median	113.5	120.4	118.0	105.0	105.2	106.7	92.6	91.8	93.2	111.1	119.8	116.7	106.7	108.1	109.7	102.7	103.1	104.3	95.1	93.5	94.7
75th percentile	120.0	127.1	124.1	107.9	107.9	109.9	93.9	93.1	94.5	119.1	126.8	123.5	110.5	112.3	114.0	105.8	105.7	107.5	96.6	95.0	96.2
25th percentile	109.5	113.6	112.8	101.3	101.7	103.4	89.2	88.5	91.0	104.7	111.5	109.9	103.2	104.7	106.0	98.7	99.3	100.9	91.3	89.8	92.3
Maximum	151.0	145.3	155.6	136.4	133.1	135.9	120.2	116.2	118.7	151.0	145.2	155.6	141.0	136.6	145.5	130.6	130.5	131.6	120.3	118.2	120.2
Vehicle Carrier																					
Pre-trial																					
Minimum	92.0	91.8	95.2	83.1	81.5	82.0	82.3	83.6	83.3	84.2	88.4	88.2	83.9	85.8	83.3	81.7	79.8	80.9	82.6	83.9	83.7
Mean	120.2	124.4	123.4	107.8	109.0	108.5	94.0	92.2	91.9	119.2	123.8	122.9	113.2	115.0	113.9	105.3	106.7	106.4	96.0	94.5	94.5
Median	110.9	119.6	112.6	99.5	99.2	100.6	87.9	86.6	86.9	109.8	119.0	111.5	101.0	102.6	102.5	97.5	97.0	98.9	89.7	88.4	89.0
75th percentile	115.5	124.2	119.7	103.3	103.6	104.7	91.7	89.9	89.6	114.4	124.0	118.9	106.7	108.8	107.9	101.3	101.2	102.7	93.6	92.1	92.1
25th percentile	106.6	111.4	107.6	95.2	94.8	96.6	84.0	84.6	84.6	104.5	110.1	105.5	96.8	97.5	98.3	93.2	92.8	94.9	85.2	85.6	85.9
Maximum	142.2	142.2	147.7	128.2	134.8	128.7	110.2	114.2	109.8	142.0	142.2	147.4	132.7	137.5	136.9	125.3	134.8	126.5	114.0	116.1	113.2
Trial																					
Minimum	95.0	97.5	102.5	83.9	83.4	84.7	83.4	83.0	84.0	88.1	94.1	96.5	88.1	91.6	95.8	80.1	80.8	82.8	83.8	83.5	84.2
Mean	127.0	130.9	130.9	111.5	114.4	116.8	99.5	103.3	104.4	126.4	130.6	130.3	118.0	118.9	121.8	109.3	111.8	113.8	101.5	104.6	105.4

Median	112.9	122.0	119.4	104.0	104.1	106.5	91.5	88.6	92.3	110.7	121.5	118.8	105.8	109.3	110.4	101.4	101.3	103.9	93.7	90.1	93.9
75th percentile	119.0	128.7	125.8	107.1	108.7	110.5	93.5	92.6	94.3	117.9	128.2	124.7	110.3	114.5	114.1	104.7	105.9	108.3	96.1	94.2	96.1
25th percentile	108.9	115.3	114.8	98.9	99.9	103.4	87.2	86.1	88.0	104.4	114.1	113.2	102.1	104.8	107.5	96.5	97.1	99.8	88.9	87.3	89.1
Maximum	152.1	152.5	151.5	135.5	141.3	139.1	125.8	131.1	126.8	151.8	152.0	151.1	145.5	140.6	141.7	134.1	138.6	134.7	127.3	132.3	127.6
Post-trial																					
Minimum	95.0	97.5	102.3	83.9	83.4	84.7	83.4	83.0	84.0	88.1	93.0	94.5	88.1	91.6	95.8	80.1	80.8	82.8	83.8	83.5	84.2
Mean	123.8	129.0	129.9	109.5	110.4	113.7	94.4	94.3	97.5	123.2	128.8	129.5	114.4	116.6	119.9	107.2	107.9	111.1	97.0	96.1	99.0
Median	113.0	120.6	118.8	104.5	105.8	107.6	92.3	91.9	93.8	110.8	120.0	117.4	106.3	108.6	110.7	102.2	103.5	105.2	94.6	93.6	95.3
75th percentile	119.2	127.4	124.9	107.5	108.4	110.5	93.6	93.1	94.9	118.3	127.0	124.0	110.2	112.8	114.7	105.1	106.3	108.0	96.3	95.2	96.6
25th percentile	109.2	114.3	113.9	100.0	102.0	104.7	88.3	88.3	92.2	104.4	112.5	110.9	102.5	105.2	107.4	97.5	99.4	102.2	90.2	89.6	93.5
Maximum	145.6	145.3	152.9	131.0	129.6	135.9	113.0	114.0	118.4	145.5	145.2	152.8	136.3	140.4	145.5	130.5	125.9	131.6	114.8	114.7	118.7

4.1.2 Haro Strait – Boundary Pass slowdown

The ECHO Program reported high levels of voluntary participation in the Haro Strait and Boundary Pass vessel slowdown trials across the three consecutive years (reported by the BC Coast Pilots to ECHO). In 2022, 93% (2,098 out of 2,262) of piloted transits adhered to the slowdown guidelines, followed by 87% in 2023 (2,442 out of 2,800) and 86% (2,434 out of 2,839) in 2024 (ECHO, 2022; ECHO, 2023; ECHO, 2024). These rates are consistent with participation levels observed in earlier years: 90% in 2021, 91% in 2020, 82% in 2019, 87% in 2018, which are significant increases from 61% in 2017 (see Appendix Table 1). In 2022 the slowdown ran from June 1st to October 31st, in 2023 it ran from June 1st to November 30th (the longest running slowdown in ECHO program history), and in 2024 from June 1st to November 15th.

SRKW were confirmed to be present in the area through visual and/or acoustic detections on 40 days in 2022, 36 days in 2023, and again 40 days in 2024. This equates to SRKW presence during approximately 26% of the trial period in 2022, 20% in 2023, and 24% in 2024 (ECHO, 2022; ECHO, 2023; ECHO, 2024). These periods of confirmed presence highlight the ongoing relevance of vessel slowdown efforts during the trials, as they coincide with times when the whales were actively using the area.

Bulk carriers remained one of the most frequently observed vessel types transiting Haro Strait and Boundary Pass during both the pre-trial and trial phases. Tugs and vessels categorized as ‘Other’, which may include recreational or smaller unidentified craft, also made up a significant proportion of the vessel traffic throughout the trial period for each of the three years (Figures 14 and 15). Tug activity was particularly notable, often operating in tandem with bulk carriers, likely in a support or escort role.

In contrast, Figures 14 and 15 show fishing vessels (red) and ferries (green) represented the least common vessel types recorded during all three years, with relatively low presence in both Haro Strait and Boundary Pass. The proportion of time commercial vessels such as containerships, vehicle carriers and tankers were present remained relatively stable across both control and trial periods, indicating no major shifts in their operational patterns due to the trial (Figures 14 and 15). This contrasted to the passenger vessel activity, which could represent tourist activities or larger non-commercial but recreational vessels. In Figures 14 and 15, the activity of this vessel type varied considerably month to month and year to year, with no clear or consistent seasonal or annual trend. Fishing vessel presence appeared to correlate closely with regional fisheries openings and declined progressively as the summer season advanced.

Notably, a decrease in the overall number of AIS-tracked vessels in the area was only observed following the conclusion of the trial period, suggesting that broader reductions in vessel traffic may be attributed to other factors independent of the slowdown initiative (Figures 14 and 15).

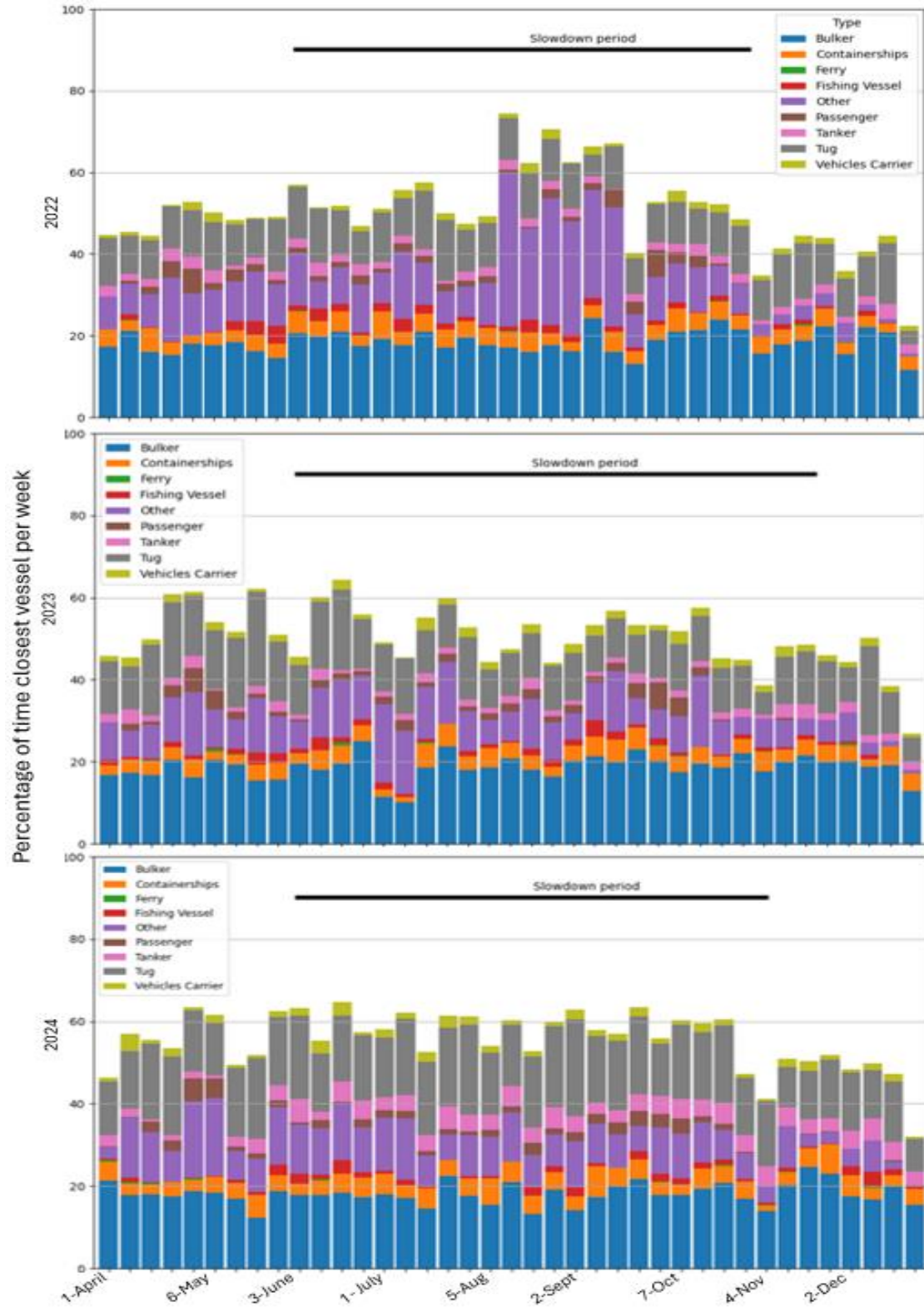


Figure 14: Proportional presence of vessel types established weekly using 5-minute data sections for pre-, during and post-trial periods, with the trial running from June 1st to October 31st in 2022 (top), June 1st to November 30th in 2023 (middle) and June 1st to November 15th in 2024 (bottom) in Haro Strait. 'Other' category includes recreational, government, and naval vessels, as well as any unidentified vessels.

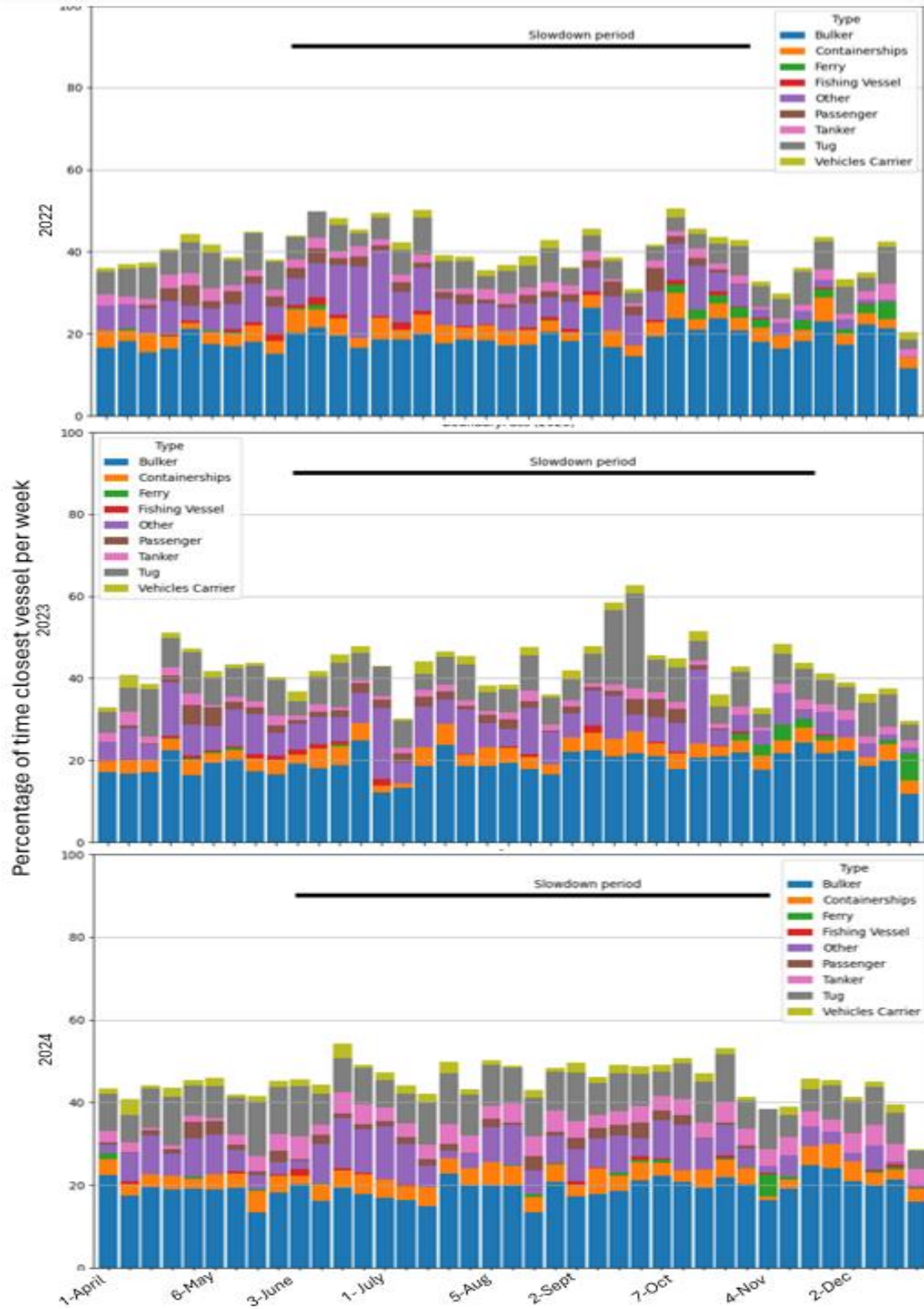


Figure 15: Proportional presence of vessel types established weekly using 5-minute data sections for pre-, during and post-trial periods, with the trial running from June 1st to October 31st 2022 (top), until November 30th 2023 (middle), and until November 15th 2024 (bottom) in Boundary Pass. 'Other' category includes recreational, government, and naval vessels, as well as any unidentified vessels.

The SOG and STW of commercial vessels transiting Haro Strait and Boundary Pass were analyzed to assess changes between the pre-trial and trial periods. The most pronounced speed reductions were observed in containerships and vehicle carriers (Figures 16 and 17 C, D), with less substantial changes noted for bulk carriers and tankers (Figures 16 and 17 A, B). Containerships exhibited the greatest decrease in speed in both regions of the slowdown, with peak speeds declining from approximately 18 knots to the targeted reduced speed of 14 knots (Figures 16 and 17). On average, all commercial vessel classes demonstrated a reduction of at least 1 knot in transit speed through both Haro Strait and Boundary Pass during the trial period (Figures 16 and 17, Tables 9 and 10).

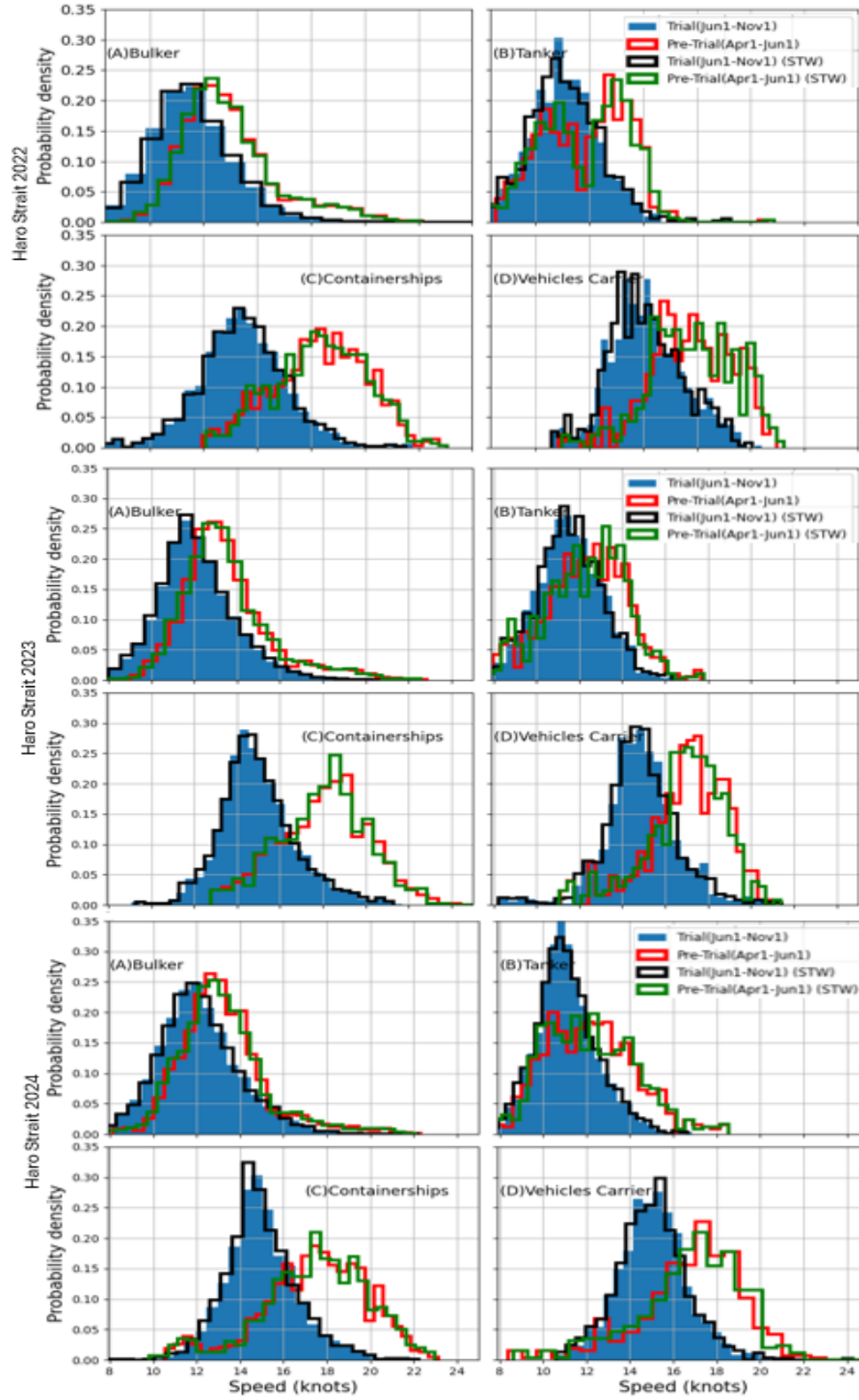


Figure 16: Comparison of the speed over ground (SOG solid blue and red outline) and speed through water (STW black and green outline) of bulkers (A), tankers (B), containerships (C), and vehicle carriers (D) between pre-trial and trial periods at Haro Strait for 2022 (top), 2023 (middle) and 2024 (bottom).

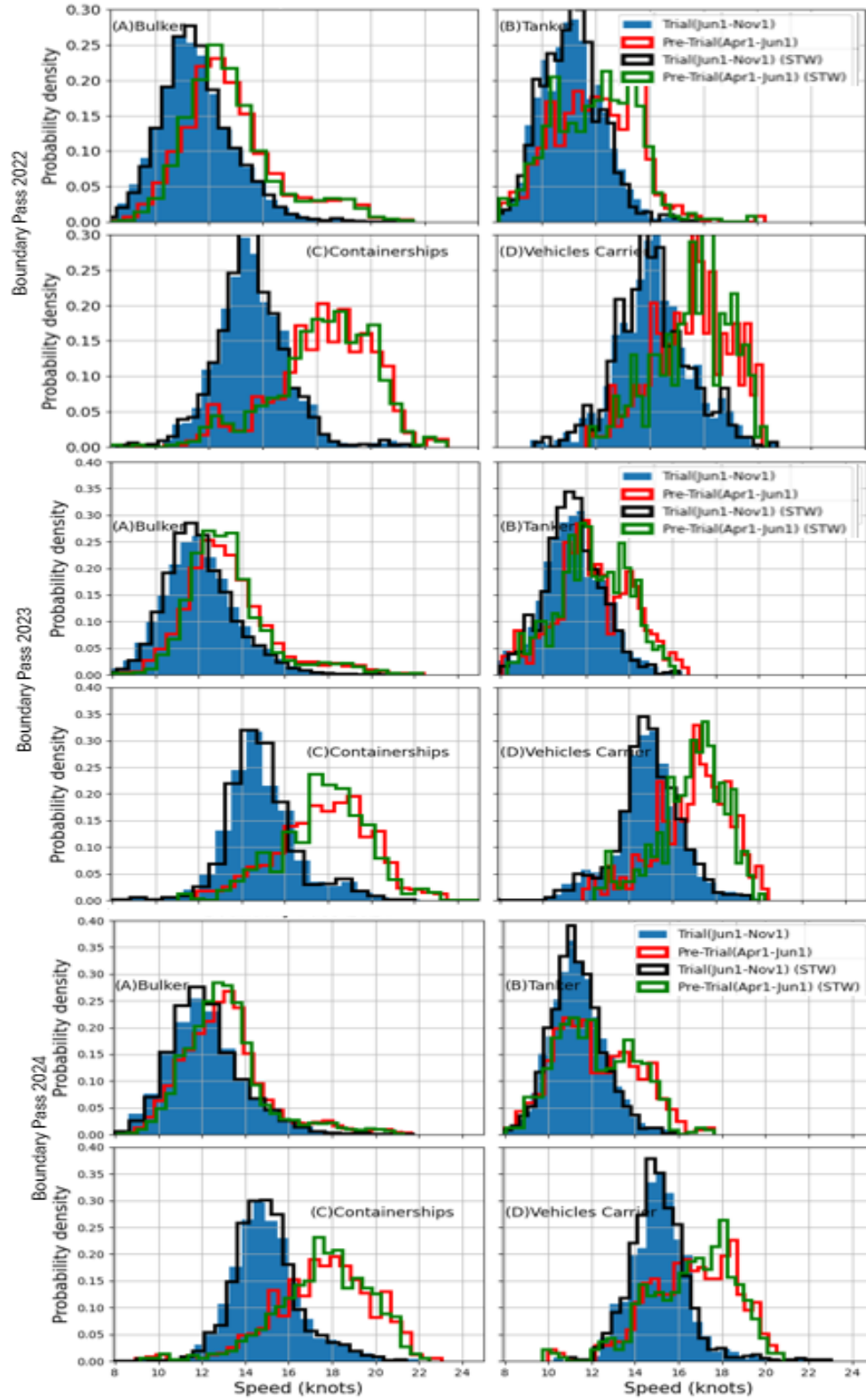


Figure 17: Comparison of the speed over ground (SOG solid blue and red outline) and speed through water (STW black and green outline) of bulkers (A), tankers (B), containerships (C), and vehicle carriers (D) between pre-trial and trial periods at Boundary Pass for 2022 (top), 2023 (middle) and 2024 (bottom).

Table 9: Speed over ground (SOG) and speed through water (STW) metrics in knots for pre-trial and trial periods for Haro Strait section of the Haro Strait-Boundary Pass slowdown for 2022, 2023 and 2024.

Metric	Bulkер			Tanker			Containerships			Vehicles Carrier		
	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Speed over ground (knots)												
Pre-trial												
Minimum	5.9	4.8	8.1	8.1	7.6	6.1	12.4	12.8	10.5	11.0	11.1	8.4
Mean	13.7	13.5	13.2	12.3	12.3	12.1	17.9	18.0	17.5	17.2	17.0	16.8
Median	13.3	13.1	13.0	12.6	12.4	12.1	18.0	18.2	17.6	17.2	17.2	17.1
75th percentile	14.7	14.3	14.1	14.0	13.6	13.5	19.5	19.5	19.2	18.8	18.4	18.4
25th percentile	12.2	12.2	12.0	10.6	11.1	10.6	16.4	16.6	16.1	15.9	16.0	15.6
Maximum	22.7	22.9	22.3	20.8	17.7	18.6	23.8	24.2	23.1	21.2	21.0	22.4
Trial												
Minimum	0.5	5.6	5.6	6.7	5.2	6.5	7.8	9.1	6.8	10.8	8.3	10.5
Mean	12.0	12.1	12.1	11.4	11.4	11.1	14.3	14.8	15.0	15.2	14.8	15.1
Median	11.8	11.9	12.0	11.3	11.4	11.0	14.3	14.7	14.8	15.1	14.7	15.1
75th percentile	13.1	13.1	13.2	12.4	12.6	11.9	15.6	15.7	15.9	16.3	15.7	16.0
25th percentile	10.7	10.9	10.9	10.3	10.3	10.2	13.1	13.8	14.0	14.0	13.9	14.1
Maximum	22.7	22.8	22.3	19.1	16.6	16.9	22.2	21.7	22.2	20.5	20.8	24.1
Post-Trial												
Minimum	7.8	8.1	6.8	8.3	7.0	7.7	9.9	12.3	8.5	11.4	8.5	12.2
Mean	13.6	12.9	13.1	12.5	11.8	12.0	17.9	16.8	17.2	17.5	16.3	16.8
Median	13.4	12.7	12.9	12.5	11.8	12.0	18.1	16.8	17.5	17.2	16.2	16.8
75th percentile	14.5	13.9	14.1	13.6	12.9	13.0	19.5	18.5	18.6	19.4	17.6	18.2
25th percentile	12.3	11.7	11.8	11.0	10.8	11.0	16.3	15.0	15.6	15.7	14.9	15.5
Maximum	22.6	21.3	21.3	19.5	16.0	16.9	24.4	22.0	21.8	22.6	21.5	23.9

Speed through water (knots)**Pre-trial**

Minimum	6.0	4.7	7.8	7.8	7.7	6.5	12.6	12.8	9.8	11.2	11.1	8.6
Mean	13.7	13.4	13.2	12.3	12.3	12.1	17.9	18.0	17.5	17.3	16.9	16.8
Median	13.3	13.1	13.0	12.6	12.5	12.0	18.0	18.1	17.6	17.3	17.2	17.1
75th percentile	14.7	14.3	14.1	13.9	13.7	13.6	19.6	19.4	19.2	18.7	18.2	18.5
25th percentile	12.2	12.1	11.9	10.7	11.0	10.5	16.4	16.6	16.0	15.9	16.1	15.6
Maximum	22.6	22.6	22.1	21.1	17.8	18.6	23.8	23.8	23.0	21.6	21.4	21.5

Trial

Minimum	0.3	5.8	6.1	6.6	5.9	6.6	7.8	9.3	7.0	10.7	8.2	10.6
Mean	11.9	12.0	12.1	11.3	11.4	11.1	14.3	14.8	14.9	15.1	14.7	15.0
Median	11.8	11.8	12.0	11.3	11.4	11.0	14.3	14.6	14.8	15.0	14.7	15.1
75th percentile	13.1	13.0	13.2	12.4	12.5	11.9	15.6	15.7	15.9	16.2	15.7	16.0
25th percentile	10.7	10.9	10.9	10.2	10.4	10.2	13.1	13.8	14.0	13.9	13.8	14.1
Maximum	22.5	22.5	22.3	19.1	16.3	16.6	21.9	21.3	22.2	20.1	21.0	24.3

Post-Trial

Minimum	8.0	8.3	6.7	7.8	7.5	7.7	10.1	12.2	8.6	11.6	8.4	12.4
Mean	13.6	12.9	13.0	12.5	11.9	12.0	17.9	16.8	17.1	17.4	16.3	16.8
Median	13.4	12.7	12.8	12.5	11.9	12.0	18.1	16.7	17.5	17.3	16.0	16.8
75th percentile	14.4	13.8	14.0	13.6	13.0	13.0	19.5	18.6	18.5	19.3	17.5	18.1
25th percentile	12.3	11.7	11.7	11.1	10.8	11.0	16.3	15.0	15.7	15.7	14.9	15.4
Maximum	21.6	21.7	20.8	19.2	16.3	16.6	24.1	22.1	22.1	22.2	21.4	24.1

Table 10: Speed over ground (SOG) and speed through water (STW) metrics in knots for pre-trial and trial periods for Boundary Pass section of the Haro Strait-Boundary Pass slowdown for 2022, 2023 and 2024.

Metric	Bulkер			Tanker			Containerships			Vehicles Carrier		
	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Speed over ground (knots)												
Pre-trial												
Minimum	1.8	6.2	8.0	7.7	8.1	4.6	8.4	11.9	9.0	12.1	11.8	10.0
Mean	13.5	13.4	13.1	12.5	12.3	11.9	17.8	17.9	17.6	17.0	16.9	16.6
Median	13.2	13.1	12.9	12.6	12.2	11.8	18.0	18.0	17.7	17.1	17.2	16.8
75th percentile	14.5	14.3	13.9	14.1	13.7	13.6	19.6	19.3	19.1	18.3	18.2	18.2
25th percentile	12.0	12.1	11.8	11.1	11.2	10.6	16.6	16.4	16.3	15.7	15.8	15.2
Maximum	22.0	22.4	21.7	20.3	16.7	17.6	23.6	23.2	23.1	20.2	20.4	20.9
Trial												
Minimum	6.1	5.8	0.8	6.7	5.1	5.3	8.1	0.3	5.6	9.4	6.3	10.3
Mean	12.0	12.0	12.1	11.4	11.3	11.3	14.5	14.7	15.0	15.2	14.8	15.1
Median	11.8	11.9	12.0	11.4	11.3	11.3	14.4	14.6	14.9	15.2	14.9	15.1
75th percentile	12.9	13.0	13.2	12.4	12.2	12.1	15.5	15.6	15.8	16.2	15.8	15.9
25th percentile	10.8	10.9	11.0	10.3	10.4	10.5	13.5	13.8	14.0	14.1	14.1	14.3
Maximum	22.1	21.5	22.1	17.5	16.5	15.9	21.7	22.3	22.0	20.8	19.9	23.1
Post-Trial												
Minimum	4.6	7.2	6.8	7.9	8.8	6.8	9.8	11.2	9.0	11.4	10.2	10.1
Mean	13.4	12.8	12.8	12.1	12.1	12.0	17.8	16.6	17.1	17.3	15.9	16.5
Median	13.2	12.7	12.7	11.9	12.0	12.0	18.0	16.3	17.4	17.8	15.9	16.7
75th percentile	14.3	13.8	13.9	13.4	13.0	12.9	19.5	18.4	18.6	19.0	17.0	18.0
25th percentile	12.1	11.5	11.5	10.6	11.1	11.2	16.4	14.6	15.7	16.1	14.6	15.2
Maximum	21.7	21.9	21.1	17.1	15.8	16.6	24.3	21.9	21.2	21.4	21.9	21.9

Speed through water (knots)**Pre-trial**

Minimum	1.5	6.3	8.1	8.0	8.4	5.1	7.9	11.0	9.2	12.2	12.4	9.7
Mean	13.5	13.3	13.1	12.4	12.4	11.9	17.8	17.8	17.6	17.0	16.9	16.6
Median	13.1	13.0	12.9	12.6	12.3	11.9	18.1	17.9	17.8	17.3	17.1	16.9
75th percentile	14.4	14.1	13.8	14.0	13.6	13.5	19.5	19.1	19.1	18.4	18.0	18.1
25th percentile	12.1	12.1	11.9	10.9	11.3	10.6	16.5	16.7	16.3	15.9	16.0	15.2
Maximum	22.0	22.4	21.3	19.9	16.1	17.6	23.5	23.2	22.5	20.4	20.3	20.9

Trial

Minimum	6.1	6.1	1.1	6.8	5.0	5.0	8.3	0.0	5.9	9.7	6.6	10.9
Mean	12.0	12.0	12.1	11.3	11.3	11.3	14.5	14.7	15.0	15.1	14.8	15.1
Median	11.8	11.8	12.0	11.3	11.3	11.2	14.4	14.7	14.8	15.1	14.9	15.0
75th percentile	12.9	12.9	13.1	12.2	12.1	12.0	15.4	15.5	15.7	16.1	15.7	15.8
25th percentile	10.8	11.0	11.0	10.4	10.5	10.5	13.5	13.9	14.0	14.1	14.1	14.3
Maximum	21.8	21.2	21.8	17.2	16.3	16.0	22.3	22.0	21.4	20.9	19.6	23.0

Post-Trial

Minimum	5.0	7.6	6.3	8.0	8.6	5.8	9.9	11.0	9.4	11.5	10.8	9.8
Mean	13.3	12.8	12.8	12.1	12.0	11.9	17.8	16.6	17.1	17.2	15.9	16.5
Median	13.2	12.6	12.7	11.9	11.9	11.9	18.1	16.3	17.4	17.6	16.0	16.8
75th percentile	14.2	13.7	13.8	13.4	13.0	12.7	19.4	18.5	18.6	18.8	17.1	17.9
25th percentile	12.1	11.6	11.6	10.7	11.0	11.1	16.4	14.6	15.8	16.1	14.7	15.4
Maximum	21.9	22.0	20.7	17.4	15.7	16.7	24.2	21.3	21.1	21.3	21.7	22.0

Records with high winds, strong currents, or detected small vessel presence were excluded to reduce environmental and acoustic variability. Table 11 summarizes the number of records removed and those used in the analysis.

Table 11: Data segments excluded due to current speeds exceeding 0.3 ms^{-1} , wind speeds above 5 ms^{-1} and small vessel presence for pre-trial, trial and post-trial periods for 2022, 2023 and 2024 for Haro Strait. Number of total records remaining after filtering, as well as percent of total number of records remaining.

	Current			Wind			Small Vessel		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-trial									
Total # records	44037	48679	50270	44037	48679	50270	44037	48679	50270
# of records excluded	11408	14886	14405	16362	17984	19213	3445	4603	4156
% excluded	25.9	30.6	28.7	37.2	36.9	38.2	7.8	9.5	8.3
Trial									
Total # records	122197	138745	142316	122197	138745	142316	122197	138745	142316
# of records excluded	31045	39815	36271	34635	48696	47811	10775	12556	12216
% excluded	25.4	28.7	25.5	28.3	35.1	33.6	8.8	9.0	8.6
Post-Trial									
Total # records	35955	38294	41813	35955	38294	41813	35955	38294	41813
# of records excluded	12156	12198	12558	19456	15749	21313	2140	2829	2875
% excluded	33.8	31.9	30.0	54.1	41.1	51.0	6.0	7.4	6.9

	2022	2023	2024
Pre-trial			
# of records remaining	18317	19253	20585
% remaining	41.6	39.6	40.9
Trial			
# of records remaining	58517	55323	65382
% remaining	47.9	39.9	45.9
Post-Trial			
# of records remaining	9658	13654	12782
% remaining	26.9	35.7	30.6

Sound levels across the frequency ranges of interest, encompassing bands associated with SRKW communication, echolocation, and vessel noise, were analyzed both prior to (Figure 18A) and following (Figure 18B) the data filtering process. Minimal differences were observed overall; however, SPLs were generally elevated during the trial period relative to the pre-trial period,

particularly in the higher frequency ranges tested. Notably, post-trial data exhibited elevated SPLs across most conditions, regardless of whether data filtering had been applied (Figure 18).

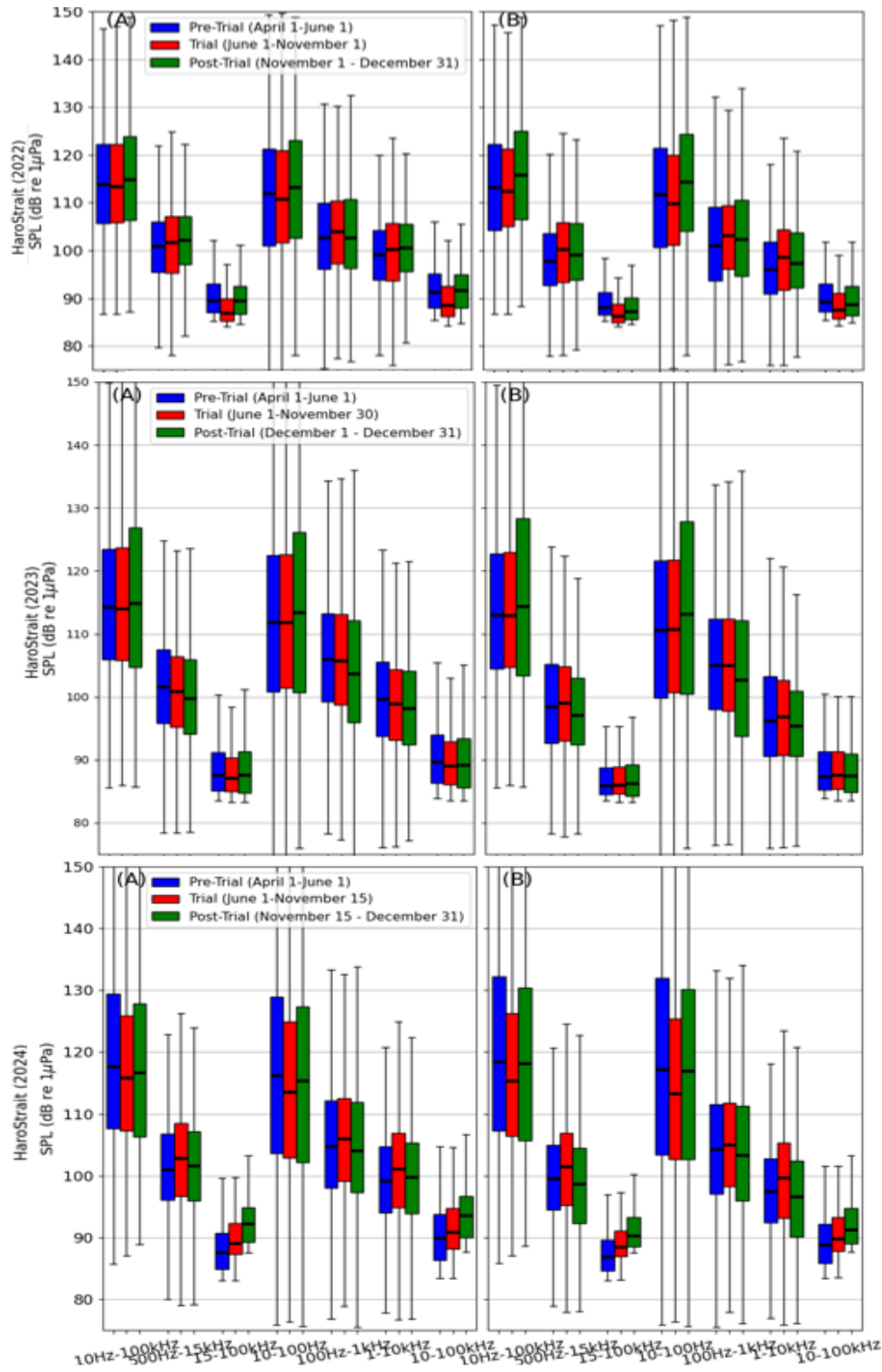


Figure 18: Sound pressure levels (dB re 1μPa) of the frequency ranges of interest at Haro Strait as recorded (A) and with the environmental restrictions of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} , and periods indicating the presence of small vessels removed (B) for 2022 (top), 2023 (middle) and 2024 (bottom).

A reduction in sound levels was not consistently seen in the change from pre- trial to trial soundscape levels, while increases in SPL were seen for the frequency ranges and the percentiles/metrics considered (Tables 12 and 13).

Table 12: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance and representing vessel presence at Haro Strait section of the Haro Strait-Boundary Pass slowdown, with and without the environmental restrictions (filters) of current less than 0.3 ms^{-1} and wind speed less than 5 ms^{-1} in 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Without Filters																					
Pre-trial																					
Minimum	86.7	85.6	85.8	77.9	78.2	78.3	85.2	83.6	83.1	73.9	73.4	75.8	73.4	74.8	73.7	75.9	76.0	76.1	85.4	83.9	83.4
Mean	126.3	130.7	138.7	109.3	109.9	109.9	96.8	95.2	94.0	126.0	130.5	138.6	114.5	116.5	115.7	106.9	107.3	107.2	98.4	97.5	96.8
Median	113.8	114.2	117.6	100.7	101.5	101.0	89.5	87.5	87.5	111.9	111.8	116.1	102.5	105.9	104.7	99.1	99.6	99.1	91.2	89.6	89.9
75th percentile	122.2	123.5	129.4	106.0	107.5	106.8	93.0	91.2	90.8	121.3	122.5	129.0	109.9	113.3	112.2	104.3	105.6	104.7	95.2	94.0	93.7
25th percentile	105.6	105.9	107.6	95.5	95.8	96.0	87.0	85.1	84.9	101.0	100.8	103.6	96.1	99.3	98.1	93.8	93.8	94.0	88.0	86.3	86.4
Maximum	149.9	154.5	160.3	137.1	136.3	134.5	127.1	126.8	122.8	149.3	154.0	160.3	139.9	145.6	141.4	132.3	130.1	129.5	127.1	126.8	122.9
Trial																					
Minimum	86.6	85.9	87.0	78.1	77.9	78.0	84.1	83.3	83.1	74.8	74.7	76.3	74.0	76.6	76.1	76.0	76.0	75.9	84.3	83.5	83.4
Mean	132.6	135.3	137.0	109.8	109.4	110.6	94.6	94.6	97.2	132.6	135.2	137.0	114.2	116.8	115.1	107.8	106.6	108.5	98.8	98.7	99.2
Median	113.2	114.0	115.8	101.6	100.8	102.7	86.9	87.1	89.0	110.7	111.8	113.5	103.9	105.7	105.9	100.1	98.9	101.0	88.5	89.0	90.8
75th percentile	122.3	123.8	125.9	107.1	106.4	108.5	90.0	90.4	92.3	120.9	122.6	125.0	110.4	113.1	112.5	105.7	104.4	106.9	92.5	92.9	94.8
25th percentile	105.8	105.7	107.2	95.4	95.2	96.7	85.3	85.0	87.3	101.6	101.4	102.9	97.2	98.8	99.1	93.7	93.1	94.8	86.1	86.1	88.2
Maximum	159.6	158.7	160.0	144.0	142.9	138.4	130.2	129.7	140.3	159.6	158.7	160.0	146.1	148.4	145.3	138.3	138.3	131.5	142.8	141.0	140.3
Post-trial																					
Minimum	87.1	85.7	88.9	79.3	78.5	78.7	84.5	83.3	87.5	78.1	76.0	75.6	76.9	74.9	75.1	77.5	77.2	76.8	84.8	83.5	87.6
Mean	129.3	133.7	136.0	110.9	110.1	109.4	94.3	94.6	96.6	129.1	133.7	135.9	115.2	115.7	115.2	108.4	107.2	107.2	97.3	96.3	98.5
Median	114.8	114.8	116.6	102.1	99.8	101.5	89.4	87.6	92.1	113.2	113.3	115.3	102.7	103.6	104.0	100.5	98.1	99.7	91.5	89.1	93.5
75th percentile	123.9	126.8	127.8	107.2	106.0	107.1	92.5	91.3	94.9	123.0	126.2	127.4	110.8	112.1	111.9	105.5	104.1	105.3	95.0	93.3	96.7
25th percentile	106.3	104.8	106.3	97.1	94.2	95.9	86.7	84.7	89.2	102.6	100.7	102.2	96.2	95.9	97.3	95.6	92.4	93.9	88.1	85.5	90.0
Maximum	148.9	154.9	157.2	141.1	135.4	131.5	123.1	127.9	126.1	148.9	154.9	157.2	141.3	141.5	142.9	131.9	130.1	129.8	124.8	128.0	127.2

With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessel filter**Pre-trial**

Minimum	86.7	85.6	85.8	77.9	78.2	78.9	85.2	83.6	83.1	74.0	73.4	75.8	73.4	74.8	73.7	76.0	76.0	77.0	85.4	83.9	83.4
Mean	126.2	128.9	139.1	107.6	109.0	108.4	94.4	92.4	92.3	126.0	128.7	139.1	114.1	115.9	115.1	105.3	105.8	105.6	96.2	95.1	95.1
Median	113.2	112.9	118.4	97.7	98.3	99.4	88.0	85.9	86.8	111.7	110.5	117.1	101.0	104.9	104.2	96.0	96.2	97.4	89.1	87.3	88.8
75th percentile	122.3	122.7	132.2	103.6	105.2	104.9	91.3	88.8	89.5	121.5	121.7	132.0	109.1	112.3	111.5	101.8	103.2	102.7	93.0	91.3	92.1
25th percentile	104.2	104.5	107.2	92.6	92.7	94.4	86.5	84.5	84.6	100.6	99.9	103.3	93.7	98.0	97.1	90.8	90.5	92.4	87.1	85.3	85.9
Maximum	147.2	151.9	158.6	130.3	136.3	133.1	123.1	120.5	117.9	147.1	151.7	158.6	135.6	139.6	141.4	123.7	128.4	129.1	123.1	120.5	120.5

Trial

Minimum	86.7	85.9	87.0	78.1	77.9	78.0	84.1	83.3	83.1	75.3	74.7	76.3	74.0	76.6	76.1	76.0	76.0	75.9	84.3	83.5	83.5
Mean	131.7	135.0	136.9	108.2	108.3	109.2	92.1	91.8	93.9	131.6	135.0	136.9	113.6	116.3	114.7	106.3	105.2	107.0	94.2	94.2	96.0
Median	112.3	112.9	115.3	100.1	99.0	101.4	86.2	86.0	88.4	109.8	110.7	113.2	103.1	104.9	105.0	98.6	96.8	99.6	87.4	87.5	89.7
75th percentile	121.3	123.0	126.3	105.9	104.8	106.9	88.7	88.9	91.1	120.0	121.8	125.4	109.4	112.3	111.7	104.4	102.7	105.3	91.0	91.3	93.3
25th percentile	105.1	104.7	106.4	93.4	93.0	95.2	85.0	84.6	87.0	101.1	100.7	102.6	96.1	97.8	98.2	91.7	90.7	93.2	85.6	85.4	87.8
Maximum	159.6	158.3	159.0	133.3	136.7	136.5	124.7	117.8	123.8	159.6	158.3	159.0	146.1	146.7	142.4	128.7	127.1	129.6	124.7	117.8	123.8

Post-trial

Minimum	88.3	85.7	88.7	79.3	78.2	78.1	84.5	83.3	87.5	78.1	76.0	75.6	76.9	74.9	76.1	77.7	76.4	76.1	84.8	83.5	87.7
Mean	130.1	135.3	136.9	109.2	108.5	108.7	92.6	91.5	95.2	130.0	135.3	136.9	114.5	115.7	115.2	106.8	105.7	106.1	95.4	93.5	97.1
Median	115.8	114.4	118.0	99.0	97.1	98.6	87.1	86.2	90.2	114.4	113.1	116.9	102.2	102.7	103.2	97.2	95.4	96.5	88.6	87.4	91.2
75th percentile	125.1	128.3	130.4	105.6	103.0	104.4	90.1	89.3	93.2	124.4	127.8	130.2	110.5	112.1	111.2	103.7	100.9	102.4	92.6	91.0	94.7
25th percentile	106.6	103.3	105.7	93.8	92.5	92.2	85.6	84.3	88.5	104.1	100.5	102.6	94.6	93.7	96.0	92.2	90.6	90.0	86.4	84.9	88.9
Maximum	148.8	153.7	155.4	133.6	132.2	131.2	112.7	110.4	116.0	148.8	153.7	155.4	137.8	135.9	142.9	126.0	124.6	125.7	116.1	112.9	118.6

Table 13: The difference in sound pressure levels in decibels (dB re 1 μ Pa) between pre-trial and trial, and trial and post-trial periods of the frequency ranges of SRKW relevance, and representing vessel presence, at the Haro Strait section of the Haro Strait-Boundary Pass slowdown. Environmental restrictions of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} and small vessels removed.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-Trial to Trial																					
Minimum	0.0	0.3	1.2	0.2	-0.3	-0.9	-1.1	-0.3	0.0	1.3	1.3	0.5	0.6	1.8	2.4	0.0	0.0	-1.1	-1.1	-0.4	0.1
Mean	5.5	6.1	-2.2	0.6	-0.7	0.8	-2.3	-0.6	1.6	5.6	6.3	-2.2	-0.5	0.4	-0.4	1.0	-0.6	1.4	-2.0	-0.9	0.9
Median	-0.9	0.0	-3.1	2.4	0.7	2.0	-1.8	0.1	1.6	-1.9	0.2	-3.9	2.1	0.0	0.8	2.6	0.6	2.2	-1.7	0.2	0.9
75th percentile	-1.0	0.3	-5.9	2.3	-0.4	2.0	-2.6	0.1	1.6	-1.5	0.1	-6.6	0.3	0.0	0.2	2.6	-0.5	2.6	-2.0	0.0	1.2
25th percentile	0.9	0.2	-0.8	0.8	0.3	0.8	-1.5	0.1	2.4	0.5	0.8	-0.7	2.4	-0.2	1.1	0.9	0.2	0.8	-1.5	0.1	1.9
Maximum	12.4	6.4	0.4	3.0	0.4	3.4	1.6	-2.7	5.9	12.5	6.6	0.4	10.5	7.1	1.0	5.0	-1.3	0.5	1.6	-2.7	3.3
Trial to Post-Trial																					
Minimum	1.6	-0.2	1.7	1.2	0.3	0.1	0.4	0.0	4.4	2.8	1.3	-0.7	2.9	-1.7	0.0	1.7	0.4	0.2	0.5	0.0	4.2
Mean	-1.6	0.3	0.0	1.0	0.2	-0.5	0.5	-0.3	1.3	-1.6	0.3	0.0	0.9	-0.6	0.5	0.5	0.5	-0.9	1.2	-0.7	1.1
Median	3.5	1.5	2.7	-1.1	-1.9	-2.8	0.9	0.2	1.8	4.6	2.4	3.7	-0.9	-2.2	-1.8	-1.4	-1.4	-3.1	1.2	-0.1	1.5
75th percentile	3.8	5.3	4.1	-0.3	-1.8	-2.5	1.4	0.4	2.1	4.4	6.0	4.8	1.1	-0.2	-0.5	-0.7	-1.8	-2.9	1.6	-0.3	1.4
25th percentile	1.5	-1.4	-0.7	0.4	-0.5	-3.0	0.6	-0.3	1.5	3.0	-0.2	0.0	-1.5	-4.1	-2.2	0.5	-0.1	-3.2	0.8	-0.5	1.1
Maximum	-10.8	-4.6	-3.6	0.3	-4.5	-5.3	-12.0	-7.4	-7.8	-10.8	-4.6	-3.6	-8.3	-10.8	0.5	-2.7	-2.5	-3.9	-8.6	-4.9	-5.2

To ensure consistency in the acoustic analysis, periods with high wind speeds and strong currents were excluded, as these environmental conditions can influence sound levels. Additionally, data segments flagged by the small vessel detector, indicating the likely presence of small craft, were removed to isolate commercial vessel noise. Table 14 summarizes the number of records excluded and those retained for analysis.

Table 14: Data segments excluded due to current speeds exceeding 0.3 ms^{-1} , wind speeds above 5 ms^{-1} and small vessel presence for pre-trial, trial and post-trial periods for 2022, 2023 and 2024 for Boundary Pass. Number of total records remaining after filtering, as well as percent of total number of records remaining.

	Current			Wind			Small Vessel		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-trial									
Total # records	36426	37989	39687	36426	37989	39687	36426	37989	39687
# of records excluded	11609	13538	14053	3188	10204	8023	3591	3870	3986
% excluded	31.9	35.6	35.4	8.8	26.9	20.2	9.9	10.2	10.0
Trial									
Total # records	96406	119047	116203	96406	119047	116203	96406	119047	116203
# of records excluded	25402	41018	32636	15380	22588	22620	9987	11767	13014
% excluded	26.3	34.5	28.1	16.0	19.0	19.5	10.4	9.9	11.2
Post-Trial									
Total # records	24345	35069	36821	24345	35069	36821	24345	35069	36821
# of records excluded	6865	13696	14270	9828	10522	15761	1864	3019	3242
% excluded	28.2	39.1	38.8	40.4	30.0	42.8	7.7	8.6	8.8

	2022	2023	2024
Pre-trial			
# of records remaining	20452	16212	18482
% remaining	56.1	42.7	46.6
Trial			
# of records remaining	53436	56281	59124
% remaining	55.4	47.3	50.9
Post-Trial			
# of records remaining	9210	13025	11950
% remaining	37.8	37.1	32.5

Sound levels within the frequency ranges of interest, encompassing SRKW communication, echolocation, and vessel noise, were analyzed for Boundary Pass both prior to (Figure 19A) and following (Figure 19B) data filtering. Similar to Haro Strait, a consistent pattern from pre-trial to

trial, and trial to post-trial sound levels was not present. Overall, minimal differences were observed; however, SPLs were generally elevated during the 2022 trial period compared to the pre-trial period. In contrast, data from 2023 indicated a reduction in noise levels during the trial period relative to both pre- and post-trial periods, regardless of whether data filtering was applied (Figure 19).

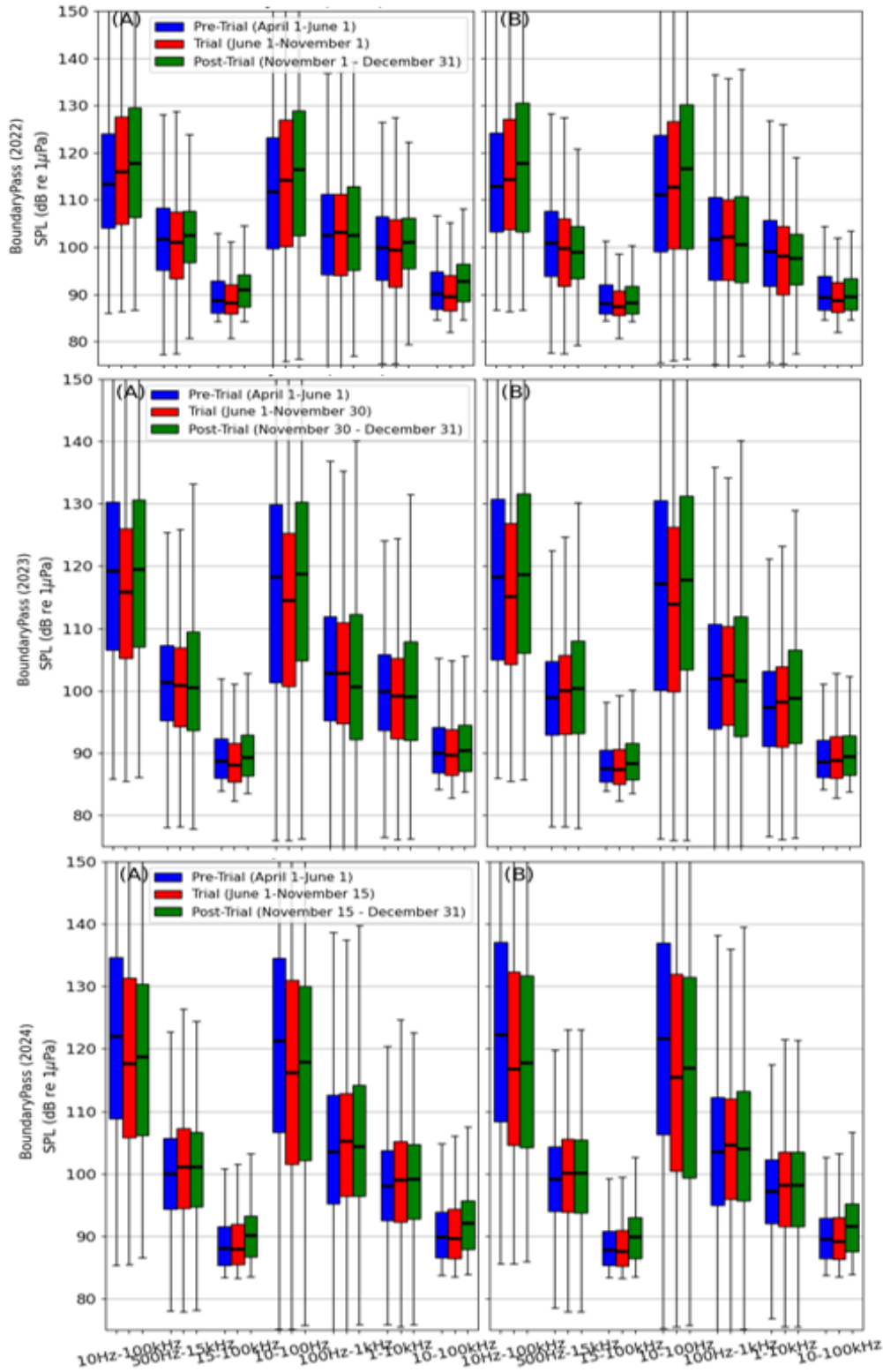


Figure 19: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of interest at Boundary Pass as recorded (A) and with the environmental restrictions of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} and periods indicating the presence of small vessels removed (B) for 2022 (top), 2023 (middle) and 2024 (bottom).

Sound levels recorded in Boundary Pass were generally comparable to those observed in Haro Strait. However, maximum SPL values were higher at Boundary Pass, likely attributable to the recorder's placement directly beneath the main shipping lane.

Although there was notable participation in the trial and a measurable number of commercial vessels reduced their speed, ambient noise levels (10 Hz -100 kHz) and low-frequency vessel noise bands (10 -100 Hz, 100 - 1000 Hz), typically associated with commercial shipping, were higher during the trial period compared to the pre-trial control (Figure 19, Table 15). Changes in SPL between the pre-trial and trial periods did not consistently indicate a reduction in noise. The most frequent decreases were observed in the mid- to high-frequency bands, which exhibited some of the largest overall changes (100 - 1000 Hz, 1 - 10 kHz; Table 16).

Table 15: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance and representing vessel presence at the Boundary Pass section of the Haro Strait-Boundary Pass slowdown, with and without the environmental restrictions (filters) of current less than 0.3 ms⁻¹, wind speed less than 5 ms⁻¹ and small vessels removed for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Without Filters																					
Pre-trial																					
Minimum SPL	86.0	85.8	85.4	77.3	78.0	78.0	84.3	83.9	83.4	74.7	76.0	75.1	74.1	73.5	73.9	75.3	76.4	75.9	84.5	84.2	83.7
Mean SPL	129.2	134.7	138.6	113.8	114.1	113.1	108.5	102.6	106.5	128.8	134.6	138.6	118.0	118.4	118.4	111.0	112.1	110.2	108.9	103.8	107.2
Median SPL	113.4	119.2	122.0	101.7	101.3	99.9	88.7	88.6	88.1	111.6	118.3	121.3	102.4	102.8	103.5	99.9	99.8	98.0	90.1	90.0	89.9
75th percentile SPL	124.0	130.2	134.7	108.3	107.3	105.7	92.8	92.3	91.6	123.2	129.9	134.5	111.3	111.9	112.7	106.4	105.8	103.7	94.8	94.2	93.8
25th percentile SPL	104.1	106.5	108.9	95.1	95.2	94.4	86.1	85.9	85.4	99.7	101.4	106.7	94.2	95.2	95.3	93.0	93.6	92.5	86.9	86.8	86.5
Maximum SPL	158.5	157.9	159.8	146.3	144.2	144.0	147.4	137.9	148.4	158.5	157.9	159.8	146.3	145.7	149.9	139.2	144.2	140.1	147.4	137.9	148.4
Trial																					
Minimum SPL	86.3	85.5	85.5	77.4	78.1	77.9	80.7	82.4	83.2	75.8	76.0	75.1	74.5	74.8	74.4	75.3	76.1	75.5	81.9	82.8	83.5
Mean SPL	134.7	135.1	138.6	114.1	112.6	113.0	104.0	100.0	104.2	134.6	135.0	138.6	118.6	117.3	117.7	111.8	110.2	110.4	105.2	102.0	105.5
Median SPL	115.8	115.7	117.7	101.0	100.9	101.0	88.1	88.0	87.9	114.2	114.4	116.1	103.1	102.8	105.2	99.4	99.1	99.0	89.5	89.7	89.7
75th percentile SPL	127.7	126.0	131.4	107.5	106.9	107.2	92.0	91.6	91.9	127.0	125.3	131.0	111.2	110.9	112.9	105.9	105.2	105.2	94.0	93.8	94.3
25th percentile SPL	104.9	105.2	105.8	93.3	94.3	94.5	85.9	85.4	85.4	100.2	100.7	101.6	94.0	94.7	96.5	91.6	92.3	92.3	86.6	86.4	86.5
Maximum SPL	158.8	158.4	159.6	147.5	144.3	140.2	142.7	141.4	145.2	158.8	158.4	159.6	148.8	152.9	145.6	143.7	137.7	138.1	142.7	141.4	145.2
Post-trial																					
Minimum SPL	86.8	86.1	86.6	79.2	77.8	78.2	84.2	83.5	83.5	76.3	76.2	75.7	77.0	74.6	75.8	77.4	76.2	75.9	84.5	83.8	83.8
Mean SPL	135.9	138.9	137.6	114.3	115.6	112.8	102.7	101.1	101.7	135.8	138.8	137.6	118.8	119.3	118.8	112.6	113.7	110.4	104.5	102.5	103.4
Median SPL	117.7	119.4	118.7	102.4	100.5	101.0	90.9	89.2	90.1	116.4	118.7	117.9	102.5	100.5	104.3	101.0	99.0	99.1	92.6	90.4	92.0
75th percentile SPL	129.5	130.7	130.4	107.6	109.4	106.6	94.2	92.9	93.3	129.0	130.3	130.0	112.8	112.2	114.2	106.1	107.9	104.7	96.4	94.5	95.8
25th percentile SPL	106.3	107.0	106.1	96.8	93.6	94.8	87.3	86.3	86.7	102.5	104.8	102.2	95.1	92.1	96.4	95.4	92.0	92.8	88.5	87.1	87.9
Maximum SPL	158.3	163.4	159.2	143.8	145.6	137.4	138.1	128.7	139.0	158.3	163.4	159.2	143.6	147.9	142.6	142.6	134.8	135.6	139.4	130.0	139.0

With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessel filter**Pre-trial**

Minimum SPL	86.6	86.0	85.6	77.5	78.2	78.0	84.4	83.9	83.4	75.5	76.2	75.3	75.2	73.6	73.9	75.5	76.6	75.9	84.6	84.2	83.7
Mean SPL	127.9	135.8	139.6	110.7	110.1	109.7	96.3	95.8	94.1	127.7	135.7	139.5	116.0	116.8	116.9	108.5	108.1	106.9	98.0	97.6	96.7
Median SPL	112.8	118.2	122.2	100.8	98.9	99.1	88.1	87.4	87.8	111.1	117.1	121.6	101.6	101.9	103.4	99.0	97.3	97.2	89.3	88.6	89.5
75th percentile SPL	124.2	130.8	137.1	107.7	104.7	104.3	92.1	90.5	90.9	123.7	130.5	137.0	110.5	110.7	112.3	105.7	103.2	102.3	93.8	92.1	92.9
25th percentile SPL	103.3	104.9	108.4	93.8	92.9	94.0	85.9	85.4	85.3	99.0	100.1	106.3	93.0	93.8	95.0	91.7	91.1	92.1	86.6	86.1	86.4
Maximum SPL	154.5	156.4	158.4	134.4	132.2	136.8	123.6	119.9	116.6	154.5	156.4	158.4	141.6	139.8	140.3	131.6	129.6	129.3	123.6	120.7	119.2

Trial

Minimum SPL	86.4	85.5	85.6	77.4	78.1	77.9	80.7	82.4	83.2	76.0	76.0	75.4	74.5	74.8	74.4	75.3	76.1	75.5	81.9	82.8	83.5
Mean SPL	134.8	136.5	139.0	111.8	110.1	110.3	98.5	94.9	95.7	134.7	136.5	139.0	117.6	115.7	116.6	109.5	107.9	107.7	99.9	97.1	97.9
Median SPL	114.2	115.1	116.8	99.6	99.9	100.1	87.4	87.3	87.5	112.7	113.8	115.5	102.1	102.4	104.6	98.0	98.1	98.1	88.6	88.8	89.2
75th percentile SPL	127.2	126.9	132.3	106.0	105.7	105.6	90.8	90.6	91.0	126.6	126.2	132.0	110.0	110.3	112.0	104.4	103.9	103.5	92.6	92.7	93.1
25th percentile SPL	103.8	104.2	104.6	91.7	93.0	93.8	85.6	84.9	85.3	99.7	99.8	100.4	92.9	94.4	95.9	89.9	91.0	91.6	86.2	85.9	86.3
Maximum SPL	158.8	158.4	159.6	141.5	134.0	138.1	130.9	121.3	127.5	158.8	158.4	159.6	147.5	141.6	143.3	139.5	133.2	138.1	131.9	121.9	127.5

Post-trial

Minimum SPL	86.8	85.8	85.9	79.2	77.9	77.9	84.2	83.5	83.5	76.3	76.0	75.8	77.0	75.0	75.1	77.4	76.3	75.5	84.5	83.8	83.8
Mean SPL	135.2	139.0	137.5	110.3	112.7	110.2	96.4	95.9	96.1	135.1	139.0	137.5	116.8	116.9	117.4	108.6	111.3	107.5	98.5	97.6	98.3
Median SPL	117.7	118.6	117.8	98.9	100.3	100.1	88.1	88.3	89.8	116.6	117.7	116.9	100.6	101.5	104.0	97.6	98.7	98.2	89.5	89.3	91.5
75th percentile SPL	130.5	131.6	131.7	104.3	108.0	105.5	91.7	91.5	93.0	130.2	131.3	131.5	110.6	111.9	113.3	102.8	106.6	103.5	93.4	92.8	95.2
25th percentile SPL	103.2	106.1	104.2	93.3	93.2	93.7	85.9	85.7	86.5	99.7	103.4	99.4	92.5	92.6	95.7	92.0	91.5	91.6	86.7	86.4	87.6
Maximum SPL	155.7	158.2	158.0	132.7	132.7	135.1	121.4	119.1	121.3	155.7	158.2	158.0	137.7	140.1	141.0	130.5	132.2	132.7	123.2	120.4	121.3

Table 16: The difference in sound pressure levels in decibels (dB re 1 μ Pa) between pre-trial and trial, and trial and post-trial periods of the frequency ranges of SRKW relevance, and representing vessel presence, at the Boundary Pass section of the Haro Strait-Boundary Pass slowdown. Environmental restrictions of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} and small vessels removed for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-Trial to Trial																					
Minimum SPL	-0.2	-0.5	0.0	-0.1	-0.1	-0.1	-3.7	-1.5	-0.2	0.5	-0.2	0.1	-0.7	1.2	0.5	-0.2	-0.5	-0.4	-2.7	-1.4	-0.2
Mean SPL	6.9	0.7	-0.6	1.1	0.0	0.6	2.2	-0.9	1.6	7.0	0.8	-0.5	1.6	-1.1	-0.3	1.0	-0.2	0.8	1.9	-0.5	1.2
Median SPL	1.4	-3.1	-5.4	-1.2	1.0	1.0	-0.7	-0.1	-0.3	1.6	-3.3	-6.1	0.5	0.5	1.2	-1.0	0.8	0.9	-0.7	0.2	-0.3
75th percentile SPL	3.0	-3.9	-4.8	-1.7	1.0	1.3	-1.3	0.1	0.1	2.9	-4.3	-5.0	-0.5	-0.4	-0.3	-1.3	0.7	1.2	-1.2	0.6	0.2
25th percentile SPL	0.5	-0.7	-3.8	-2.1	0.1	-0.2	-0.3	-0.5	0.0	0.7	-0.3	-5.9	-0.1	0.6	0.9	-1.8	-0.1	-0.5	-0.4	-0.2	-0.1
Maximum SPL	4.3	2.0	1.2	7.1	1.8	1.3	7.3	1.4	10.9	4.3	2.0	1.2	5.9	1.8	3.0	7.9	3.6	8.8	8.3	1.2	8.3
Trial to Post-Trial																					
Minimum SPL	0.4	0.3	0.3	1.8	-0.2	0.0	3.5	1.1	0.3	0.3	0.0	0.4	2.5	0.2	0.7	2.1	0.2	0.0	2.6	1.0	0.3
Mean SPL	0.4	2.5	-1.5	-1.5	2.6	-0.1	-2.1	1.0	0.4	0.4	2.5	-1.5	-0.8	1.2	0.8	-0.9	3.4	-0.2	-1.4	0.5	0.4
Median SPL	3.5	3.5	1.0	-0.7	0.4	0.0	0.7	1.0	2.3	3.9	3.9	1.4	-1.5	-0.9	-0.6	-0.4	0.6	0.1	0.9	0.5	2.3
75th percentile SPL	3.3	4.7	-0.6	-1.7	2.3	-0.1	0.9	0.9	2.0	3.6	5.1	-0.5	0.6	1.6	1.3	-1.6	2.7	0.0	0.8	0.1	2.1
25th percentile SPL	-0.6	1.9	-0.4	1.6	0.2	-0.1	0.3	0.8	1.2	0.0	3.6	-1.0	-0.4	-1.8	-0.2	2.1	0.5	0.0	0.5	0.5	1.3
Maximum SPL	-3.1	-0.2	-1.6	-8.8	-1.3	-3.0	-9.5	-2.2	-6.2	-3.1	-0.2	-1.6	-9.8	-1.5	-2.3	-9.0	-1.0	-5.4	-8.7	-1.5	-6.2

Periods during which bulk carriers, tankers, containerships, or vehicle carriers were identified as the closest approaching vessels exhibited similar SPLs across both the control and trial periods, with minimal variation between vessel types (Figures 20 and 21). The consistency between the observed changes in the overall acoustic environment (Figure 18 and 19), and the vessel-specific SPL comparisons (Figures 20 and 21, Tables 17 and 18), indicates that these commercial vessel classes are the primary contributors to variations in the ambient sound field.

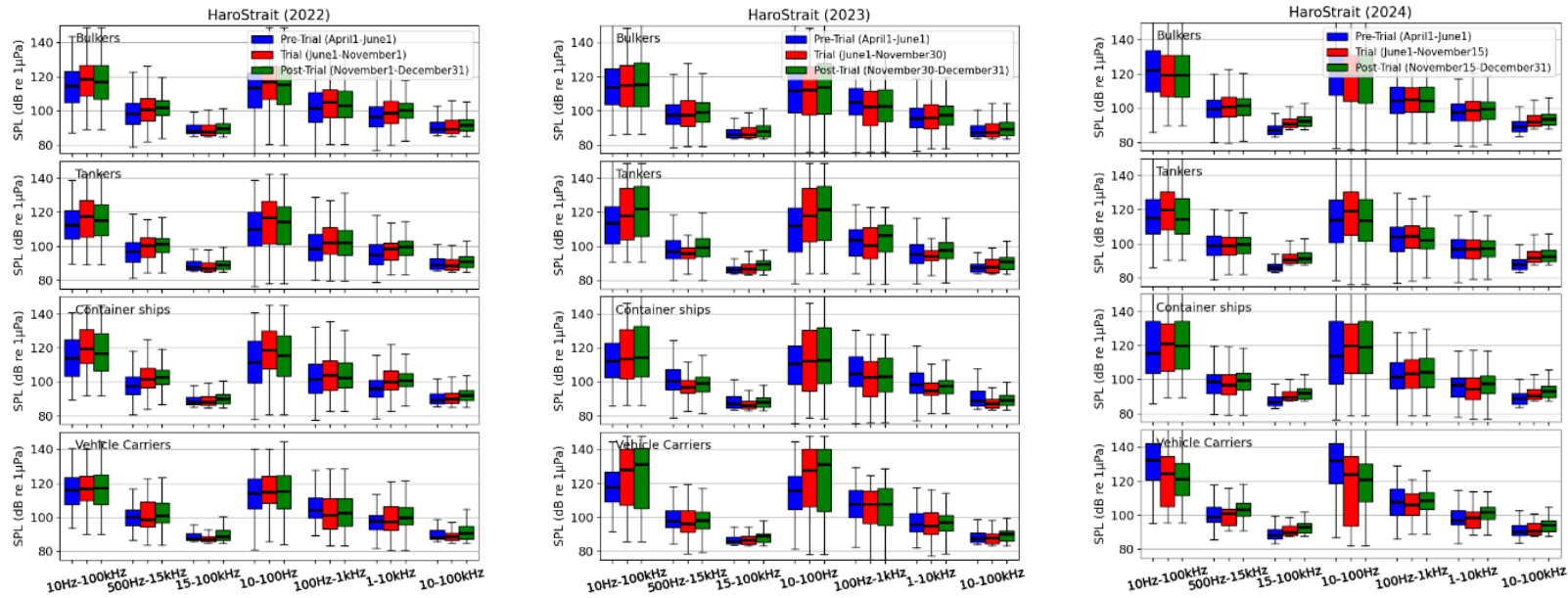


Figure 20: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of interest in Haro Strait. The pre-trial control (blue), trial periods (red), post-trial (green) were compared for Bulkers, Tankers, Containerships, and Vehicle carriers within the broadband ambient noise (10 Hz to 100 kHz), SRKW communication (500Hz -15 kHz) and echolocation (15-100 kHz), and decadal bands for years 2022 (left), 2023 (centre) and 2024 (right).

Table 17: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance and representing vessel presence at Haro Strait for periods when bulkers, tankers, containerships, and vehicle carriers are the vessels present for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessel filter																					
Bulker																					
Pre-trial																					
Minimum	87.2	85.7	85.9	78.7	78.3	79.5	85.2	83.6	83.2	74.3	74.4	76.3	73.4	75.4	73.9	76.8	76.3	77.8	85.4	83.9	83.5
Mean	126.4	130.6	138.6	108.9	109.2	110.7	94.7	92.6	92.6	126.1	130.4	138.6	115.1	117.1	116.0	106.8	106.3	107.1	96.9	95.4	96.0
Median	114.5	113.7	121.8	98.0	97.5	99.2	88.0	85.8	86.9	113.3	111.7	121.0	101.4	104.8	104.1	96.3	95.5	97.2	89.1	87.1	88.9
75th percentile	123.2	124.6	133.6	104.6	103.9	104.8	91.6	89.0	89.7	122.4	123.6	133.6	110.9	113.2	112.5	102.5	101.6	102.5	93.4	91.3	92.0
25th percentile	105.1	103.7	109.7	92.3	92.2	94.7	86.5	84.4	84.8	101.5	99.0	107.7	93.5	97.7	97.1	90.8	90.1	92.6	87.2	85.2	86.1
Maximum	143.6	150.5	155.6	126.4	132.8	130.5	112.5	112.3	107.9	143.5	150.2	155.6	132.4	138.5	133.3	124.0	126.9	125.7	114.9	115.0	112.1
Trial																					
Minimum	89.2	86.4	89.9	81.8	79.3	79.6	84.7	83.3	87.6	80.3	76.1	75.9	80.2	76.1	79.4	80.0	77.8	77.5	84.9	83.5	87.7
Mean	131.2	131.9	136.1	110.8	111.2	110.8	94.4	92.3	98.3	131.1	131.8	136.1	115.0	115.2	115.4	109.2	107.9	108.5	97.6	94.7	100.3
Median	118.5	114.8	119.2	100.4	97.5	100.6	87.5	85.9	90.6	116.8	111.9	118.7	105.0	102.3	104.8	98.6	95.8	98.4	89.1	87.2	91.9
75th percentile	126.9	126.5	131.1	107.4	106.1	106.5	91.7	90.1	93.7	126.5	126.0	131.0	112.6	111.8	112.2	105.8	103.9	104.0	94.4	92.6	95.7
25th percentile	109.0	102.5	106.7	94.3	91.0	94.9	85.7	84.2	88.8	107.0	97.7	104.0	96.2	91.5	97.6	92.6	89.3	92.6	86.6	84.8	89.3
Maximum	148.8	148.7	153.0	129.0	132.2	128.5	112.8	105.6	117.8	148.8	148.7	153.0	131.0	132.6	133.0	127.4	124.6	125.6	115.9	108.3	119.1
Post-trial																					
Minimum	89.2	86.4	89.9	81.8	79.3	79.6	84.7	83.3	87.5	80.1	76.1	75.7	80.2	76.1	79.4	80.0	77.8	77.5	84.9	83.5	87.7
Mean	131.2	134.2	137.8	110.6	110.3	109.0	93.7	92.7	96.7	131.1	134.1	137.8	114.7	116.3	115.1	108.2	107.2	106.7	96.7	94.9	98.4
Median	116.6	115.4	119.0	101.8	99.1	101.4	89.3	87.8	92.3	115.3	113.6	118.2	103.0	102.4	104.2	100.1	97.5	99.5	91.4	89.2	93.4
75th percentile	126.5	128.3	131.1	106.1	104.9	105.6	92.6	91.5	94.9	126.0	127.7	131.0	111.5	112.5	112.3	104.5	102.9	103.6	95.1	93.3	96.6
25th percentile	106.9	102.5	106.5	97.3	93.5	95.7	86.8	84.8	89.4	103.8	98.2	103.1	96.2	93.8	97.8	95.6	91.7	93.6	88.2	85.6	90.1
Maximum	148.8	152.0	154.9	132.4	132.2	126.7	111.6	106.6	115.5	148.8	152.0	154.9	132.0	132.6	132.7	125.2	124.6	124.7	114.3	110.0	117.1

Tanker**Pre-trial**

Minimum	89.5	90.8	86.1	81.5	80.3	79.1	85.5	83.7	83.1	76.6	78.0	78.5	79.9	84.0	76.9	79.1	78.3	77.3	85.7	84.0	83.5
Mean	123.1	130.1	137.7	106.9	108.1	107.3	92.2	90.2	90.1	122.6	129.9	137.7	113.3	118.0	114.2	104.6	106.5	104.5	94.3	93.2	93.2
Median	112.3	113.5	115.0	96.7	96.8	98.6	87.6	86.0	85.7	109.8	112.0	113.8	98.3	103.4	104.1	95.0	95.4	96.6	88.7	87.3	87.6
75th percentile	120.9	123.2	126.1	102.3	103.3	104.7	91.1	88.0	88.1	120.1	122.4	125.7	107.3	109.7	109.8	101.1	101.3	102.8	92.7	89.7	90.7
25th percentile	104.3	101.4	106.1	90.8	92.8	93.4	86.2	84.4	84.1	100.3	96.7	100.6	91.8	94.3	95.5	89.2	90.2	91.5	86.7	85.0	85.0
Maximum	139.0	150.5	151.0	121.7	124.1	122.0	107.6	105.7	103.8	138.9	150.2	151.0	129.0	138.5	129.8	119.9	124.0	116.6	107.7	110.9	107.6

Trial

Minimum	89.1	90.8	90.6	84.5	80.0	82.2	84.7	83.3	87.6	78.1	84.1	76.2	79.6	77.7	78.1	83.4	78.6	79.5	85.0	83.6	87.7
Mean	130.0	134.9	137.1	105.0	110.0	107.8	91.9	95.8	95.4	129.9	134.9	137.0	112.5	112.7	113.1	102.7	108.2	105.9	93.6	98.3	97.5
Median	117.3	117.9	119.9	100.3	95.5	98.7	86.8	86.4	90.6	116.5	117.7	119.0	102.1	100.2	104.3	98.4	93.9	96.8	88.4	87.6	91.5
75th percentile	126.7	134.0	130.4	105.1	99.1	104.1	90.4	89.6	94.2	126.7	134.0	130.4	110.9	111.0	110.6	102.1	97.7	102.3	92.3	92.4	95.8
25th percentile	105.7	104.1	108.2	93.7	93.0	93.6	85.2	84.0	88.6	101.5	102.9	105.3	95.8	92.8	97.4	92.2	91.7	91.1	86.0	84.5	89.1
Maximum	142.4	148.5	151.8	116.0	126.5	121.8	105.6	112.3	113.5	142.4	148.5	151.8	127.0	122.9	126.7	113.7	125.1	121.0	107.0	115.3	115.7

Post-trial

Minimum	89.1	90.8	90.6	84.5	80.0	82.2	84.7	83.3	87.6	78.1	84.1	76.2	79.6	77.7	78.1	83.4	78.6	79.5	85.0	83.6	87.7
Mean	128.9	134.8	135.7	107.3	109.5	107.6	93.1	94.2	95.4	128.8	134.8	135.6	115.2	113.5	113.7	105.3	107.4	105.2	95.3	96.6	97.2
Median	115.0	121.8	114.3	101.3	99.0	99.5	89.0	89.1	91.4	114.1	121.3	113.5	101.8	106.1	102.1	99.5	97.7	97.4	90.8	90.8	92.4
75th percentile	124.4	135.1	126.5	104.8	104.6	103.8	91.8	91.5	94.6	123.4	135.1	126.1	109.6	112.8	109.4	103.0	102.3	102.1	94.1	93.5	96.2
25th percentile	106.4	106.0	105.7	96.4	93.9	94.3	86.5	86.0	89.0	101.2	103.7	101.4	94.7	96.8	97.1	94.9	92.7	92.4	87.6	86.5	89.6
Maximum	142.2	148.5	151.8	123.0	126.5	123.2	108.3	112.3	113.5	142.2	148.5	151.8	132.9	122.9	129.2	121.3	125.1	121.0	110.0	115.3	115.7

Containership**Pre-trial**

Minimum	89.5	86.0	85.9	80.7	78.9	79.6	85.3	83.7	83.1	78.1	75.4	76.3	77.4	75.7	73.9	78.3	77.0	78.0	85.6	84.0	83.5
Mean	127.6	131.8	140.5	108.7	109.9	105.7	93.5	93.6	91.2	127.3	131.6	140.5	116.0	116.4	113.6	106.7	107.6	103.7	96.0	96.9	93.2
Median	113.7	111.9	115.3	97.5	100.2	98.5	88.1	87.1	86.6	111.3	110.4	113.8	101.3	104.7	101.5	96.0	98.1	96.5	89.2	88.8	88.5
75th percentile	124.9	122.6	134.2	102.8	107.4	103.0	91.2	91.5	89.7	123.9	121.1	134.2	110.4	114.8	110.2	101.1	105.4	100.9	93.1	94.6	91.8

25th percentile	103.5	102.6	103.9	92.6	95.4	92.0	86.6	84.9	84.5	99.3	98.8	97.2	93.5	97.4	94.5	91.0	93.4	89.8	87.3	85.9	85.5
Maximum	140.7	150.5	156.0	124.8	124.4	122.1	110.0	105.9	105.9	140.7	150.5	156.0	132.4	130.2	127.5	123.5	121.3	121.9	113.1	110.0	108.7
Trial																					
Minimum	91.9	86.4	89.4	84.1	79.3	79.0	84.7	83.3	87.5	80.8	78.7	78.7	82.8	76.1	78.8	82.6	77.8	76.9	85.1	83.5	87.6
Mean	133.4	134.4	138.8	114.1	106.2	106.0	95.2	89.7	94.3	133.3	134.4	138.8	117.6	113.4	112.9	110.4	104.5	104.1	99.6	91.7	95.9
Median	119.3	113.3	120.7	101.4	96.5	96.7	87.9	86.0	89.6	118.5	111.9	119.6	103.6	102.6	103.3	99.7	94.8	94.3	89.8	87.1	90.2
75th percentile	130.6	130.5	132.7	108.2	100.8	103.0	91.6	88.6	93.1	130.0	130.4	132.7	112.4	111.9	111.6	106.4	99.4	100.9	93.6	89.9	94.3
25th percentile	110.9	101.7	105.1	96.8	93.6	90.9	86.3	84.3	88.0	107.8	94.5	103.8	95.1	91.6	94.9	95.5	92.1	88.2	87.3	84.9	88.4
Maximum	145.1	146.2	153.0	133.6	121.6	119.1	111.2	104.7	105.5	145.1	146.1	153.0	135.4	128.0	127.5	128.6	119.9	117.2	118.1	107.0	107.7
Post-trial																					
Minimum	91.9	86.4	89.4	84.1	79.3	79.0	84.7	83.3	87.5	80.8	78.4	78.7	82.8	76.1	78.8	82.6	77.8	76.9	85.1	83.5	87.6
Mean	131.5	137.1	139.9	111.7	106.4	106.3	93.2	91.2	96.3	131.3	137.1	139.9	116.4	114.7	114.8	108.0	104.5	104.1	96.1	93.0	97.4
Median	116.3	113.9	119.6	102.4	98.9	99.3	89.7	87.7	91.9	115.4	112.6	118.7	102.2	103.0	104.2	100.7	97.4	97.4	92.0	89.1	92.9
75th percentile	128.1	132.6	134.3	106.8	102.9	103.9	92.6	90.5	94.5	127.0	132.0	134.3	111.3	113.9	112.6	105.1	101.1	102.0	94.9	92.4	96.0
25th percentile	106.7	103.1	105.9	98.5	94.2	93.8	87.3	85.1	88.8	103.2	99.0	103.6	96.4	94.2	95.4	97.3	93.0	91.8	88.9	86.1	89.3
Maximum	145.1	153.1	153.0	133.6	121.6	119.6	109.3	104.7	115.5	145.1	153.1	153.0	135.4	128.0	129.7	122.7	119.9	117.2	111.7	107.0	115.5
Vehicle Carrier																					
Pre-trial																					
Minimum	93.6	91.7	95.4	86.4	84.6	85.8	85.6	83.6	83.2	81.0	81.4	82.7	89.3	82.7	86.0	81.7	82.3	83.4	85.9	84.0	83.7
Mean	127.0	131.6	143.4	108.0	108.9	109.7	95.5	93.1	94.5	126.8	131.5	143.4	113.7	116.8	117.0	105.7	106.2	107.6	96.8	96.2	97.6
Median	115.7	117.4	131.9	100.0	97.7	98.8	87.3	85.8	88.1	113.8	115.5	131.8	104.0	107.5	107.5	97.6	95.7	96.9	88.1	87.3	90.1
75th percentile	123.3	126.4	142.1	104.5	104.0	104.8	90.4	88.5	91.5	122.4	124.1	142.1	111.5	115.8	115.3	101.2	102.3	102.7	92.4	90.9	93.9
25th percentile	107.6	108.9	120.4	95.3	94.2	96.1	86.4	84.5	86.0	105.1	104.7	118.7	99.5	100.1	100.0	92.8	91.7	94.3	87.1	85.3	88.0
Maximum	140.2	144.3	156.0	120.1	122.0	123.2	110.6	104.7	105.7	140.2	144.3	156.0	127.8	129.4	129.1	118.7	117.3	120.8	110.8	107.7	109.6
Trial																					
Minimum	90.0	85.7	95.7	83.7	78.6	90.9	84.7	83.3	87.5	85.9	78.4	82.2	83.3	74.9	88.7	80.7	77.3	88.6	85.0	83.5	87.7
Mean	127.2	139.4	137.4	109.1	107.3	104.9	91.0	89.5	92.4	127.0	139.4	137.4	113.9	114.8	110.9	107.4	104.8	102.4	94.8	92.3	93.7

Median	116.7	127.6	124.0	98.6	96.0	100.7	86.9	86.4	89.6	114.6	127.5	123.9	101.2	107.3	105.8	97.1	94.8	98.4	88.3	87.6	90.6
75th percentile	124.3	140.0	134.4	109.2	104.0	103.5	88.8	89.0	93.8	124.1	140.0	134.4	111.0	115.5	112.5	106.3	102.8	102.0	90.8	90.5	95.2
25th percentile	110.0	107.1	105.3	94.3	91.4	94.2	85.7	84.3	88.3	108.2	106.3	93.7	93.3	96.4	100.1	92.4	90.1	92.4	86.4	84.7	88.6
Maximum	140.0	147.7	150.4	122.8	119.2	115.7	105.6	102.2	98.8	140.0	147.7	150.4	128.7	124.8	120.8	121.1	116.3	114.0	110.1	106.0	101.0
Post-trial																					
Minimum	90.0	85.7	95.7	83.7	78.6	90.9	84.7	83.3	87.5	84.1	78.4	82.2	83.3	74.9	88.7	80.7	77.3	88.6	85.0	83.5	87.7
Mean	129.5	139.0	135.4	110.3	109.0	109.4	94.0	92.0	96.7	129.3	138.9	135.4	114.6	116.5	115.0	108.7	106.7	106.8	97.3	94.5	98.4
Median	116.9	130.9	121.1	100.8	98.1	103.2	88.5	88.7	93.0	115.1	130.9	120.6	102.4	107.4	108.5	99.7	96.8	101.6	90.4	89.9	94.1
75th percentile	124.9	140.3	130.4	108.2	103.0	107.2	92.3	90.6	95.3	124.6	140.2	130.0	111.2	116.9	113.5	105.9	101.1	104.8	94.8	92.1	97.0
25th percentile	107.5	105.0	111.5	97.0	93.4	99.4	86.4	85.1	89.5	105.0	103.5	107.9	95.0	95.2	103.6	95.5	92.1	97.5	87.4	86.3	90.4
Maximum	144.3	147.7	150.4	123.2	120.8	120.5	107.8	102.2	110.9	144.2	147.7	150.4	128.7	128.7	126.0	121.5	119.3	119.0	112.0	106.0	112.1

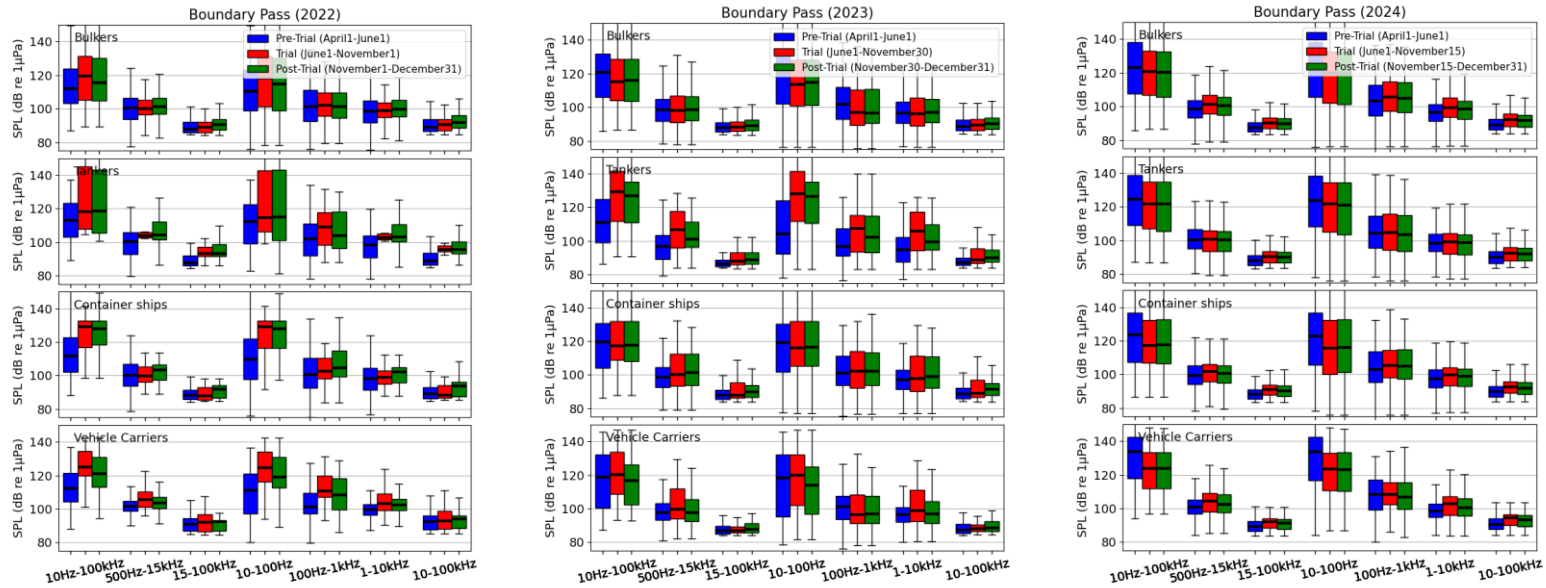


Figure 21: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of interest in Boundary Passage. The pre-trial control (blue), trial periods (red), post-trial (green) were compared for Bulk carriers, Tankers, Containerships, and Vehicle carriers within the broadband ambient noise (10 Hz to 100 kHz), SRKW communication (500Hz -15 kHz) and echolocation (15-100 kHz), and decadal bands for years 2022 (left), 2023 (center) and 2024 (right).

Table 18: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance and representing vessel presence at Boundary Pass for periods when bulkers, tankers, containerships, and vehicle carriers are the vessels present for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessel filter																					
Bulker																					
Pre-trial																					
Minimum	87.0	86.0	85.9	77.6	78.2	78.1	84.5	84.0	83.4	76.0	76.4	76.1	75.9	73.8	74.2	75.6	76.7	75.9	84.7	84.3	83.8
Mean	127.4	136.4	140.0	110.5	110.7	108.5	95.3	95.9	93.5	127.1	136.3	140.0	116.2	116.8	116.8	108.1	108.6	106.0	97.1	97.9	96.1
Median	112.1	120.8	123.0	100.4	98.4	98.4	87.8	87.7	87.5	110.4	120.3	122.0	101.2	101.5	103.3	98.4	96.7	96.5	89.0	88.7	89.0
75th percentile	123.9	131.9	138.3	106.7	105.0	103.5	92.0	91.1	90.5	123.1	131.6	138.2	111.3	112.1	112.7	104.7	103.3	101.4	93.7	92.7	92.4
25th percentile	103.4	105.9	107.6	93.9	92.0	93.3	85.9	85.5	85.2	99.1	102.0	105.8	92.8	93.0	94.4	91.9	90.4	91.2	86.6	86.2	86.2
Maximum	149.7	155.8	157.4	131.5	129.5	128.6	113.5	112.8	113.3	149.6	155.8	157.4	135.2	138.5	136.8	124.4	124.6	128.5	115.2	114.7	113.8
Trial																					
Minimum	89.5	86.8	86.6	80.4	77.9	79.0	84.4	83.6	83.6	78.1	76.3	76.5	79.4	75.5	76.2	79.1	76.4	76.7	84.8	83.9	83.9
Mean	133.4	137.4	138.3	113.0	118.1	113.1	101.1	99.8	101.0	133.2	137.3	138.3	117.0	119.3	118.4	111.0	113.2	110.9	102.7	101.5	103.0
Median	119.5	115.1	120.9	100.2	98.0	101.3	89.1	88.2	90.4	118.3	113.8	120.1	102.3	96.8	105.9	99.0	96.3	99.4	90.7	89.3	92.3
75th percentile	131.4	128.7	133.1	105.3	107.1	107.0	92.1	91.6	93.3	131.3	128.2	132.7	109.8	110.3	114.9	103.8	105.8	105.1	93.9	92.9	95.7
25th percentile	105.4	103.9	106.8	96.7	90.9	95.7	85.9	85.8	87.0	101.4	100.8	102.0	95.6	89.3	97.6	95.1	89.1	93.7	87.3	86.4	88.2
Maximum	151.1	153.7	155.3	134.3	145.6	137.4	122.7	124.9	128.2	151.1	153.7	155.3	135.6	145.6	136.8	132.4	134.1	135.6	124.5	126.0	129.8
Post-trial																					
Minimum	89.5	86.6	86.6	80.4	77.9	79.0	84.4	83.6	83.6	78.1	76.3	76.5	79.4	75.5	76.2	79.1	76.4	76.7	84.8	83.9	83.9
Mean	134.4	138.9	138.1	110.6	113.0	110.6	96.7	94.8	96.2	134.3	138.9	138.0	117.6	115.3	117.4	109.0	112.1	108.4	98.6	96.4	98.5
Median	115.6	115.8	120.3	101.2	98.6	100.5	90.5	88.9	90.0	115.0	114.8	119.6	101.4	96.7	104.7	99.9	97.1	98.6	91.9	90.0	91.8
75th percentile	130.2	128.7	132.7	106.5	106.4	105.5	93.9	92.5	92.9	130.1	128.3	132.6	109.6	110.7	114.5	105.2	104.8	103.5	96.0	93.8	95.0
25th percentile	105.1	103.7	105.6	96.9	92.2	94.9	87.3	86.3	86.7	99.1	101.3	101.5	94.7	90.8	96.7	95.6	90.8	92.8	88.7	87.0	87.9
Maximum	151.1	154.6	155.3	129.4	129.1	129.0	115.7	111.8	117.6	151.1	154.6	155.3	139.3	135.1	135.3	128.0	127.3	126.8	117.7	112.3	117.6

Tanker**Pre-trial**

Minimum	89.4	86.7	87.2	79.8	79.3	80.5	84.6	84.0	83.5	82.8	78.0	78.0	78.2	76.7	78.7	78.2	77.4	78.5	84.8	84.3	83.9
Mean	124.9	135.5	141.2	111.3	111.1	114.3	94.0	94.9	94.2	124.5	135.5	141.2	115.0	114.3	120.0	106.5	109.5	107.9	95.9	97.0	96.8
Median	113.1	110.9	124.4	100.4	96.6	100.2	87.7	86.4	88.2	112.3	104.5	123.7	101.8	96.9	104.3	98.4	94.8	98.3	89.0	87.4	90.2
75th percentile	123.4	125.0	138.7	106.0	103.7	106.6	92.1	89.0	91.4	122.4	124.3	138.4	111.2	107.7	114.7	103.9	102.2	104.1	93.6	90.1	93.6
25th percentile	103.0	99.1	109.1	92.8	89.1	95.3	85.9	85.0	85.4	99.3	92.3	108.4	92.0	91.4	95.5	90.7	87.8	93.6	86.6	85.6	86.5
Maximum	137.4	151.1	155.0	131.5	128.3	136.8	111.7	110.8	108.7	137.2	151.1	155.0	134.0	132.8	139.4	119.9	126.1	122.7	113.1	112.4	111.7

Trial

Minimum	104.9	91.0	86.9	86.6	84.2	79.3	86.1	83.7	83.7	99.0	83.4	76.2	88.1	83.4	76.2	85.3	83.3	77.3	86.4	84.0	84.1
Mean	144.6	142.2	141.4	120.2	117.9	113.1	108.6	104.9	101.9	144.6	142.1	141.4	119.7	124.7	120.2	118.5	116.5	110.7	110.6	106.4	104.2
Median	118.0	129.4	121.9	103.8	106.8	100.7	93.2	87.9	90.4	114.7	128.2	121.7	108.9	107.4	104.8	102.6	106.0	99.0	95.8	89.0	92.4
75th percentile	145.0	141.8	134.7	106.1	117.6	106.0	97.4	93.1	93.6	142.9	141.7	134.5	117.9	115.6	115.8	105.2	117.2	104.3	98.2	95.6	95.9
25th percentile	108.1	112.0	106.9	102.7	96.1	93.6	91.6	86.2	87.0	106.4	111.9	105.2	98.4	93.6	94.5	101.5	94.6	91.8	94.3	86.9	88.1
Maximum	151.6	153.4	157.5	132.8	128.4	134.7	121.8	120.0	126.5	151.6	153.4	157.5	131.6	140.1	138.8	130.9	126.1	133.4	123.7	121.8	128.7

Post-trial

Minimum	100.6	91.0	86.9	86.6	84.2	79.3	86.1	83.7	83.7	81.1	83.4	76.2	88.1	83.4	76.2	85.3	83.3	77.3	86.4	84.0	84.1
Mean	143.6	142.5	141.6	115.7	115.4	110.8	99.5	94.8	96.2	143.6	142.4	141.5	118.8	122.9	119.3	114.2	114.7	107.5	102.1	96.5	98.6
Median	118.6	126.7	121.6	104.2	101.1	100.4	93.3	89.0	90.1	115.1	126.5	121.1	103.9	102.2	103.6	103.0	99.5	98.6	95.8	90.2	92.2
75th percentile	143.1	135.3	134.7	112.4	111.3	105.3	98.9	93.2	93.3	143.1	135.1	134.5	118.1	115.1	115.2	110.7	109.8	103.7	100.3	94.9	95.4
25th percentile	105.5	111.2	105.7	101.5	96.3	93.4	91.5	86.4	86.9	101.0	110.8	103.7	96.3	93.4	93.5	100.3	94.8	91.6	93.3	87.6	88.0
Maximum	151.6	154.6	157.5	126.3	125.8	133.0	109.7	106.0	114.4	151.6	154.6	157.5	130.2	140.1	136.4	125.3	125.6	124.8	112.9	108.3	116.2

Containership**Pre-trial**

Minimum	88.1	86.3	86.6	78.8	79.0	78.4	84.4	84.0	83.6	76.1	77.7	78.2	75.3	75.6	74.9	76.6	77.3	76.2	84.6	84.3	84.0
Mean	131.4	135.7	139.5	110.3	109.3	110.4	94.4	93.5	94.3	131.3	135.7	139.5	115.4	115.1	116.8	108.1	107.6	108.0	96.3	95.4	97.3
Median	111.7	119.7	123.7	100.0	98.7	99.2	88.1	87.7	88.3	109.5	119.1	122.8	100.6	101.0	103.1	98.1	97.2	97.5	89.2	88.7	89.8
75th percentile	122.6	130.5	136.7	106.9	104.5	105.3	91.3	91.2	91.0	121.9	130.3	136.7	110.6	111.2	113.7	104.6	102.8	103.0	93.0	92.2	93.1

25th percentile	102.2	104.2	107.5	93.9	92.7	94.1	85.7	85.4	85.4	97.6	101.6	105.8	92.6	93.9	95.2	91.6	91.4	92.4	86.4	86.1	86.6
Maximum	152.8	151.5	154.2	128.2	124.6	126.5	111.7	107.5	109.4	152.7	151.5	154.2	134.0	129.4	132.4	123.8	122.4	125.0	114.1	110.0	112.4
Trial																					
Minimum	98.4	87.7	86.9	89.1	79.1	79.5	84.8	83.7	83.5	88.5	77.2	75.8	84.0	76.8	76.2	87.9	77.2	77.5	85.3	84.0	84.0
Mean	132.8	139.4	137.4	115.4	116.4	114.9	100.2	103.3	104.5	132.7	139.4	137.3	117.2	116.2	119.6	113.0	114.8	112.7	102.2	104.5	106.7
Median	129.3	117.4	117.3	99.8	100.3	101.7	87.8	87.7	91.0	129.3	116.1	115.8	102.7	102.3	105.3	98.9	97.9	99.8	88.4	88.9	92.7
75th percentile	132.6	132.0	132.4	105.5	112.4	106.1	93.0	95.4	93.7	132.6	132.0	132.3	110.4	113.9	114.6	103.1	111.3	104.1	94.1	97.1	95.9
25th percentile	116.7	108.8	106.8	96.0	93.3	95.8	85.6	86.4	87.8	116.3	105.5	100.3	98.2	92.3	98.1	95.2	90.4	93.5	86.6	86.8	88.9
Maximum	141.6	152.4	153.6	130.6	132.5	134.7	116.1	123.4	126.5	141.6	152.4	153.6	131.2	131.9	138.8	128.4	129.7	133.4	117.9	124.2	128.7
Post-trial																					
Minimum	98.4	87.7	86.9	89.1	79.1	79.5	84.8	83.7	83.5	88.5	77.2	75.8	84.0	76.8	76.2	87.9	77.2	77.5	85.3	84.0	84.0
Mean	135.3	139.9	137.7	112.2	115.1	109.3	95.5	96.3	95.9	135.2	139.9	137.7	121.1	117.7	117.7	109.5	114.1	106.8	97.8	98.2	97.8
Median	128.0	117.7	117.7	103.3	101.4	100.7	91.8	89.9	90.4	127.9	116.6	116.0	104.5	102.3	105.1	102.1	99.1	98.9	93.7	91.5	91.7
75th percentile	132.6	131.8	132.8	106.4	112.4	105.4	94.3	93.8	93.4	132.6	131.8	132.7	114.9	113.4	114.7	104.8	110.8	103.5	96.2	95.0	95.6
25th percentile	118.4	108.1	106.4	97.3	94.0	95.0	86.5	86.8	86.9	116.6	105.5	101.5	99.3	94.0	97.6	95.9	92.2	92.9	87.6	87.8	88.3
Maximum	149.2	154.4	153.6	127.0	128.2	126.0	107.7	109.3	113.7	149.1	154.4	153.6	134.7	136.1	132.9	123.7	127.7	123.6	111.2	110.9	113.8
Vehicle Carrier																					
Pre-trial																					
Minimum	88.2	87.3	94.2	78.2	81.1	81.2	84.9	84.0	83.6	80.2	78.7	84.0	75.9	76.4	80.2	76.2	80.0	79.5	85.2	84.3	84.0
Mean	123.5	135.0	142.3	108.2	109.8	109.8	95.5	94.3	93.9	123.1	135.0	142.3	112.9	112.3	117.9	106.3	108.8	107.4	97.0	97.0	96.7
Median	112.5	118.4	133.8	101.7	97.7	100.8	90.9	87.0	89.2	111.2	118.1	133.8	101.0	101.4	108.2	99.7	96.4	98.5	92.4	87.4	90.6
75th percentile	121.4	132.0	142.6	104.7	103.3	105.2	94.3	89.5	92.4	121.1	131.9	142.6	109.4	107.6	117.1	102.7	101.0	102.9	96.2	90.8	94.2
25th percentile	104.3	100.3	117.8	98.6	93.4	96.7	87.0	85.0	86.4	97.1	95.3	116.6	97.2	93.6	99.3	96.4	92.2	94.8	87.8	85.5	87.7
Maximum	136.8	145.4	153.0	121.5	127.3	125.1	110.5	109.5	106.0	136.4	145.4	152.9	127.4	126.5	130.8	119.1	126.5	123.9	110.8	112.5	109.9
Trial																					
Minimum	101.3	93.1	96.9	96.0	82.1	85.4	84.6	84.1	83.9	94.0	81.9	86.9	93.2	78.1	83.1	90.3	80.4	83.6	85.1	84.4	84.3
Mean	133.6	135.9	136.3	118.5	114.7	115.5	102.9	98.3	102.3	133.5	135.8	136.2	120.6	116.6	120.2	116.3	113.9	111.5	105.1	100.8	104.3

Median	125.1	120.3	123.9	105.4	99.6	104.3	92.1	87.1	92.2	124.6	119.8	123.3	110.6	96.5	108.4	103.1	99.0	102.8	93.0	88.1	94.4
75th percentile	134.5	133.5	133.2	110.4	111.8	109.2	96.8	89.5	93.9	134.3	132.2	132.8	119.6	108.2	115.3	109.2	111.1	107.1	98.9	90.7	96.6
25th percentile	119.7	108.8	111.9	101.2	93.8	97.8	86.4	85.7	88.4	116.2	102.1	110.5	107.2	91.2	102.5	99.2	92.5	96.2	88.3	86.6	89.9
Maximum	142.5	146.6	147.9	130.6	129.3	133.0	116.1	115.1	120.7	142.5	146.6	147.9	131.2	132.3	136.4	128.4	128.6	125.6	117.9	117.1	122.5
Post-trial																					
Minimum	94.4	92.7	96.9	90.6	82.1	85.4	84.6	84.1	83.9	89.2	81.9	86.9	86.2	78.1	83.1	89.5	80.4	83.6	85.1	84.4	84.3
Mean	132.0	134.1	136.4	114.2	110.9	114.7	97.3	92.5	98.1	131.8	134.1	136.3	117.7	112.3	120.0	112.3	110.0	109.6	100.0	96.0	100.2
Median	120.9	116.7	123.8	103.6	97.6	102.4	92.5	87.7	91.3	118.9	114.0	123.2	108.2	96.6	106.7	102.2	97.0	100.4	94.2	88.5	93.2
75th percentile	131.0	126.0	133.2	107.1	105.6	108.4	93.2	91.1	93.8	130.8	125.1	133.1	118.1	107.7	115.3	105.8	104.3	105.9	95.9	92.5	96.1
25th percentile	113.2	102.5	111.7	100.5	92.6	97.5	86.9	85.6	87.9	112.6	97.0	110.3	99.4	91.3	99.7	99.1	91.3	95.4	88.5	86.3	89.5
Maximum	142.5	146.6	147.5	126.7	124.3	133.0	107.5	104.4	114.4	142.5	146.6	147.4	129.1	124.6	136.4	123.7	123.3	124.8	111.2	110.8	116.2

The observed variability in sound levels and the corresponding increases in SPL observed in Haro Strait likely arise from multiple interacting factors. Figure 22 presents the SOG distributions for four vessel classes transiting Haro Strait in 2015 - prior to implementation of any slowdown measures - and in 2025, the most recent slowdown year. A modest reduction in transit speeds is evident in 2025 during the slowdown period (July 14th - November 30th), most notably for vehicle carriers and container ships, with comparatively smaller changes observed for bulk carriers and tankers. The total number of transits by vehicle carriers and container ships ($n = 1,312$) was substantially lower than that of bulkers and tankers ($n = 4,114$). This disparity in traffic volume likely contributes to the limited reduction in overall SPL, as bulkers and tankers constitute a much larger proportion of the acoustic footprint within the study area. Together, these indicate that very few vessels are required to make large changes in their speed to participate in the slowdown.

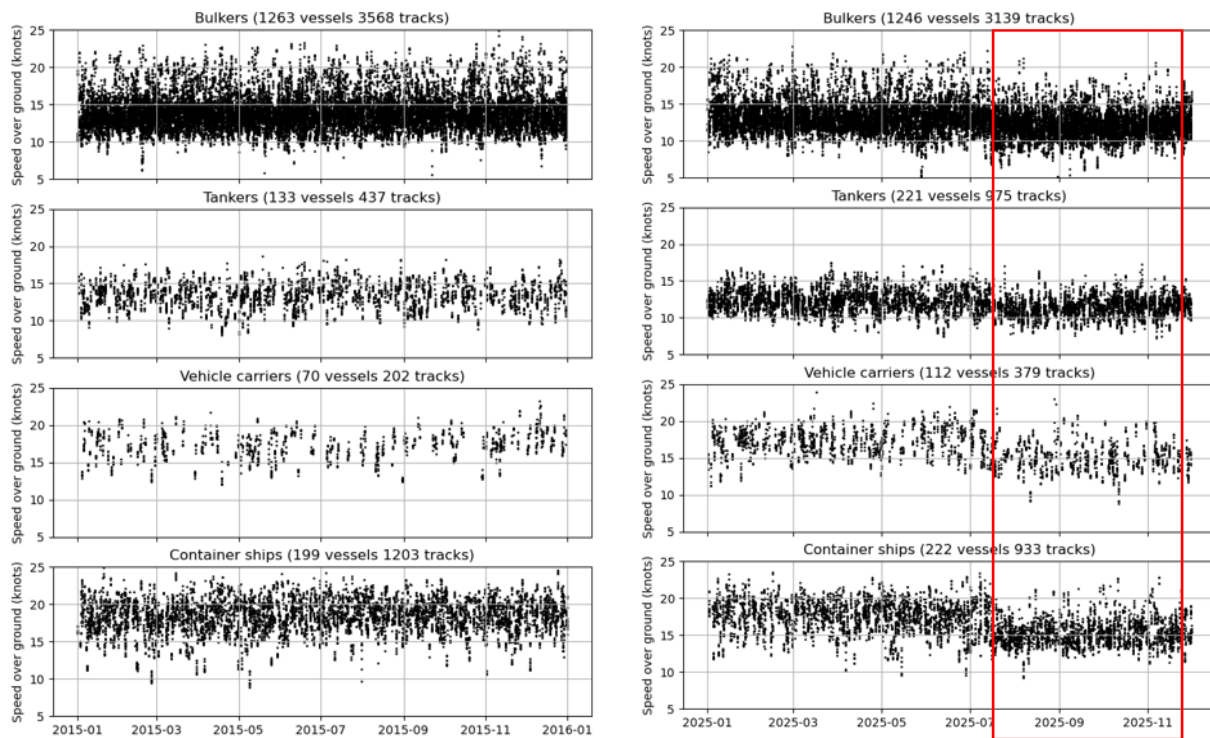


Figure 22 - Speed-over-ground distributions for four vessel classes transiting Haro Strait by month. Left: 2015 baseline conditions prior to implementation of voluntary speed-reduction measures. Right: 2025 conditions during the most recent slowdown period (July 14th - November 30th), indicated by the red-outline.

Vessel presence in time and the number of vessels present at one time was considered to see if the slowdown did appreciably congregate vessels in Haro Strait, and lessen the overall potential for sound levels to be reduced. This was considered by analyzing for changes in vessel activity within Haro Strait during the slowdown trial periods, compared to control periods using -derived metrics. Figure 23 shows the evaluation of the time, in minutes and hours in a day when vessels are present, as well as the instances when there were more than one vessel present within the 8 km polygon. No appreciable increase in these metrics representing traffic intensity during the trial windows. In fact, 2023 exhibits a slight decrease in total vessel-hours and time spent with more than one vessel, while 2022 and 2024 show only marginal increases in traffic relative to adjacent non-trial months (Figure 23). Together increases in each of these metrics could add to the reason why there is no clear or substantial SLP reduction due to these measures. Along with only a small proportion of the traffic transiting through the Strait needing to alter speed to be considered a participant also likely reduces the intensity of the change. The metrics considered do not show a notable increase in time spent with vessels in the area or clustering of vessels, as might be expected by increasing the overall transit duration and, consequently, the cumulative exposure time of radiated noise within the study area. Another potential factor is the redistribution of acoustic energy across the spectrum: while speed reductions are effective at lowering the highest noise levels, they can shift energy into lower frequency ranges. Vessels not operating at their optimal conditions may in fact increase emissions in certain frequencies. These considerations will be examined in complementary analyses to be presented in subsequent technical documentation.

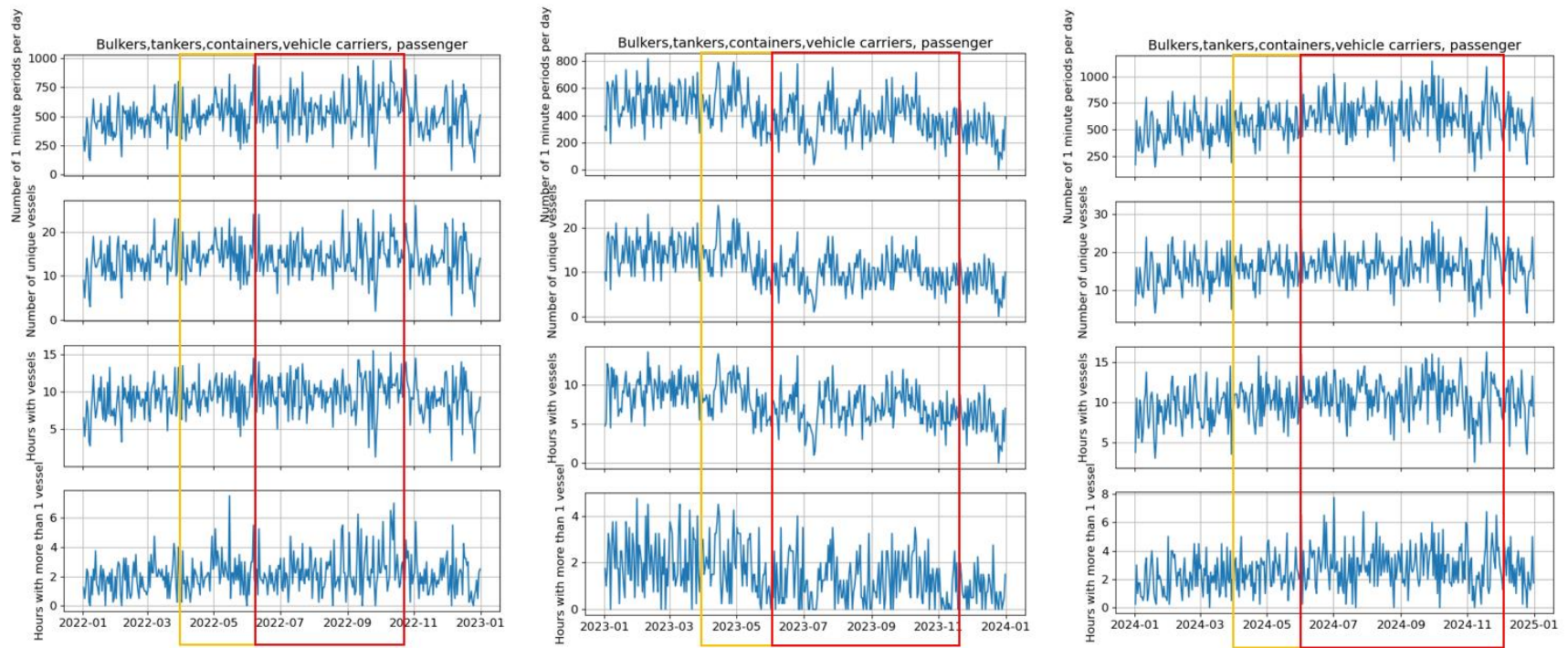


Figure 23 - Daily metrics of marine traffic activity in Haro Strait for 2022 (left), 2023 (middle), and 2024 (right), including hours with >1 vessel present, total vessel-hours, number of unique vessels, and count of 1-minute observation intervals. Vessel classes include bulk carriers, tankers, container ships, vehicle carriers, and passenger vessels. The pre-trial period is indicated by the yellow outline, and the slowdown trial period by the red outline.

4.2. Lateral displacement assessments

4.2.1. Strait of Juan de Fuca Lateral Displacement

A comparative analysis was conducted on the transits of all tug vessels within the designated trial area over a six-month pre-, post- and active trial period (June 1st - October 31st for all 3 years). The data showed that the routes taken by tugs were consistent across all periods (pre, during and post-trial), with no substantial deviation in overall transit paths. Notable concentrations of tug activity were observed south of the Management Enhancement Area, with clear peaks in transit density occurring at approximately 5,000 m and 11,000 m from the Jordan River mooring site (Figure 24A). These peaks correspond to the primary inbound and outbound shipping lanes, which are further highlighted by the inclusion of bulker vessel tracks in Figure 24. This comparison illustrates that tug vessel traffic was predominantly aligned with, or situated slightly south, of these established shipping lanes, regardless of whether the transits occurred during the trial or the control period. Notably, there was minimal observed change in the lateral distance between tug transits and the Jordan River mooring when comparing the pre-trial and trial phases, suggesting that the trial measures did not significantly alter tug navigation patterns (Figure 24A).

To assess longer-term trends, vessel transit data from the 2022, 2023, and 2024 trial years were examined. Overall, the distance of tug transits from the Jordan River mooring remained relatively stable across all three years. Across the full trial duration, vessel presence within 5,000m of the Jordan River mooring - particularly within the boundaries of the Management Enhancement Area, remained consistently low (Figure 24B). This pattern suggests a sustained avoidance or minimization of activity in close proximity to the mooring site, regardless of annual variation or trial progression.

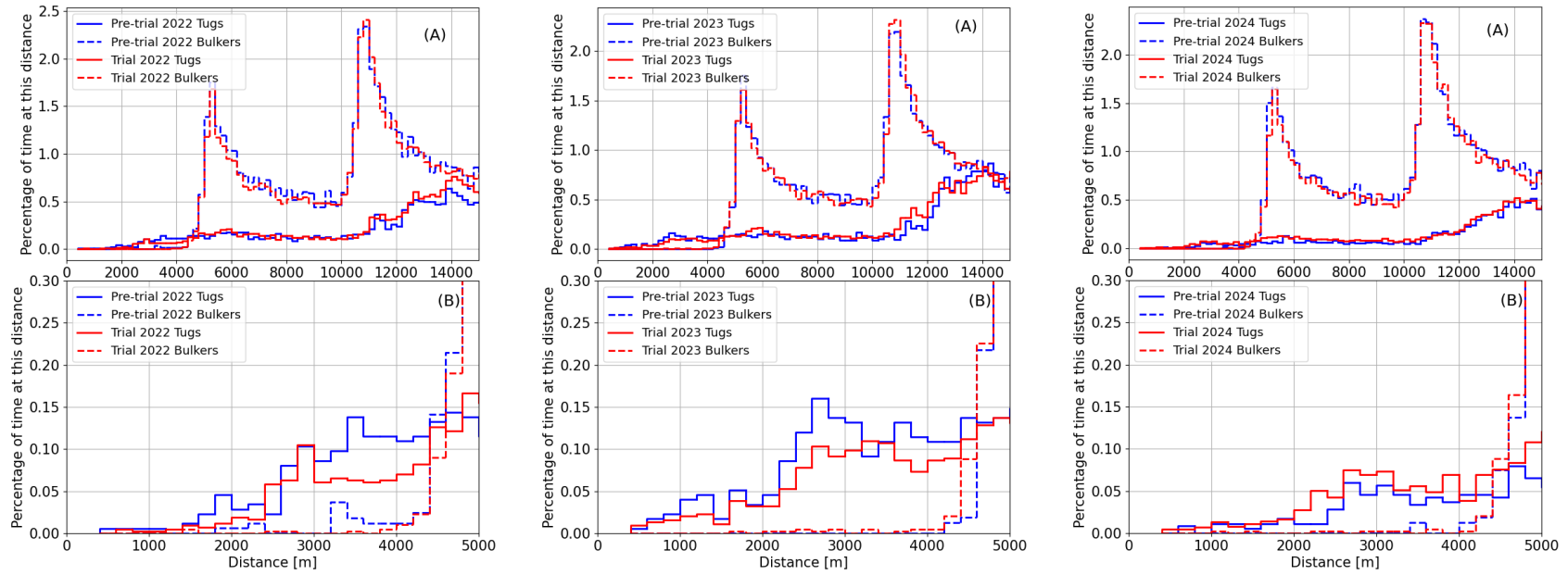


Figure 24: Comparison of pre-trial and trial passage distance for tugs and bulkers (A), and the use of waters within 5000 m of the Jordan River mooring (to the outbound shipping lane) (B) by tugs and bulkers, of pre-trial and trial periods from 2022 (left), 2023 (center) and 2024 (right).

Periods characterized by high winds and strong currents were excluded from the analysis to minimize environmental variability. Additionally, records indicating the presence of small vessels, identified using the small vessel detector, were removed. Table 19 provides a detailed summary of the number of records excluded and those retained for analysis.

Table 19: Data segments excluded due to current speeds exceeding 0.3 ms^{-1} , wind speeds above 5 ms^{-1} and small vessel presence for pre-trial, trial and post-trial periods of 2022, 2023 and 2024 for Jordan River. Number of total records remaining after filtering, as well as percent of total number of records remaining.

	Current			Wind			Small Vessel		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-trial									
Total # records	87840	87747	87840	87840	87747	87840	87840	87747	87840
# of records excluded	38710	39080	36857	36840	44319	44486	2101	2579	2664
% excluded	44.1	44.5	42.0	41.9	50.5	50.6	2.4	2.9	3.0
Trial									
Total # records	215060	217928	218581	215060	217928	218581	215060	217928	218581
# of records excluded	95003	84217	83290	99206	106165	96811	12576	10960	11816
% excluded	44.2	38.6	38.1	46.1	48.7	44.3	5.8	5.0	5.4
Post-Trial									
Total # records	84915	87483	73142	84915	87483	73142	84915	87483	73142
# of records excluded	38904	39242	34782	23942	17909	17923	1600	2484	2455
% excluded	45.8	44.9	47.6	28.2	20.5	24.5	1.9	2.8	3.4
	2022	2023	2024						
Pre-trial									
# of records remaining	28346	23213	24935						
% remaining	32.3	26.5	28.4						
Trial									
# of records remaining	59858	60475	66866						
% remaining	27.8	27.7	30.6						
Post-Trial									
# of records remaining	32537	36182	26902						
% remaining	38.3	41.4	36.8						

Sound levels across frequency bands associated with SRKW communication, echolocation, and vessel presence were analyzed before and after data filtering for the pre-, trial, and post-trial periods (Figure 25A,B). Minimal differences were observed between the pre- and trial periods in the communication and echolocation bands; however, elevated levels were noted in the post-trial recordings, especially notable in 2024 (Figure 25, Tables 20 and 21).

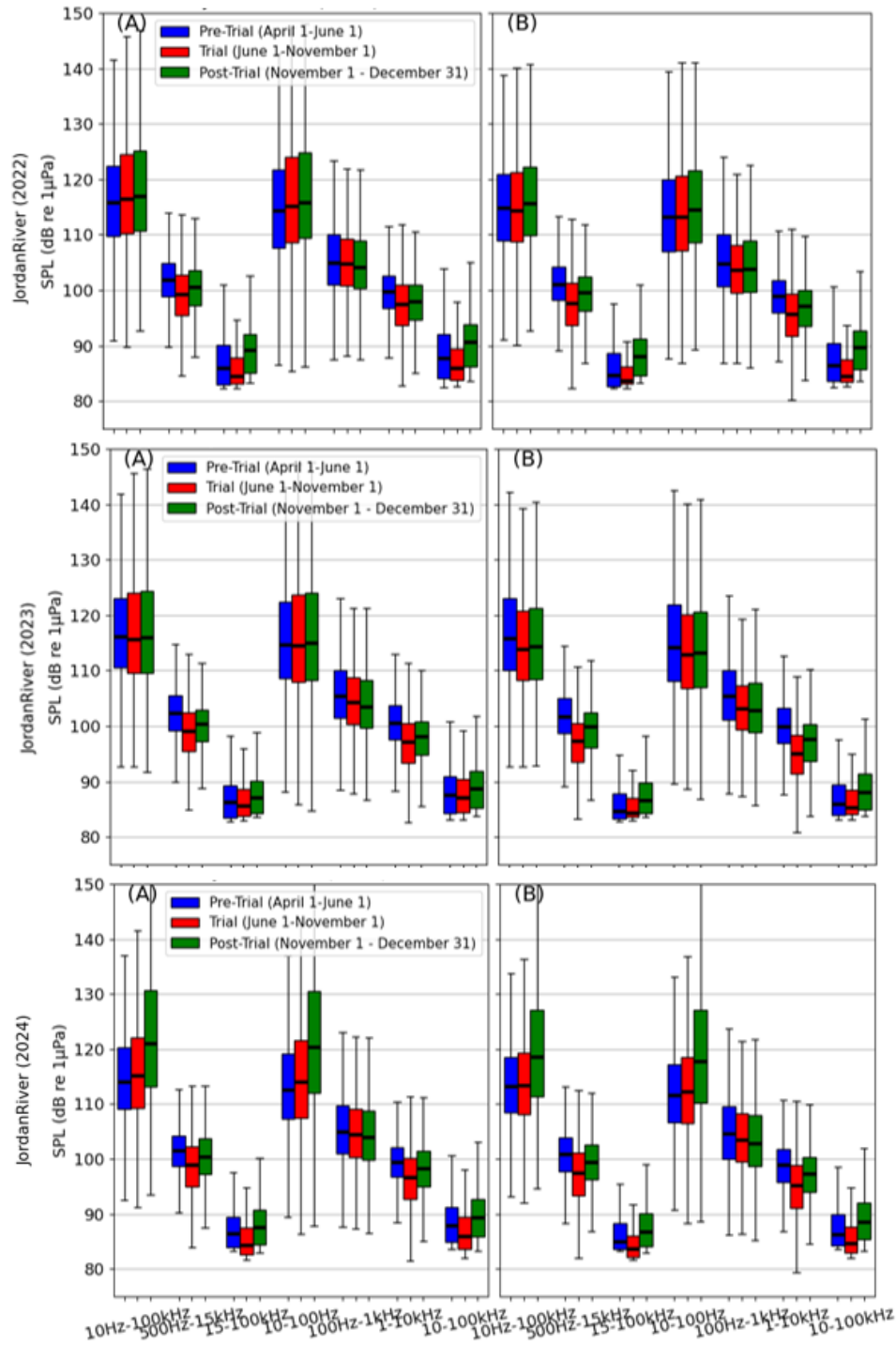


Figure 25: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of interest at Jordan River as recorded (A) and with the environmental restrictions of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} , and periods indicating the presence of small vessels removed (B) for 2022 (top), 2023 (middle) and 2024 (bottom).

Table 20: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance and representing vessel presence at Jordan River with and without the environmental restrictions (filters) of current less than 0.3 ms⁻¹, wind speed less than 5 ms⁻¹, and small vessels removed for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Without Filters																					
Pre-trial																					
Minimum SPL	90.7	92.8	90.6	86.0	82.6	86.8	82.2	82.8	83.3	81.6	85.4	79.3	81.8	84.2	81.4	79.8	80.8	84.7	82.5	83.0	83.6
Mean SPL	125.4	131.6	128.3	105.6	107.1	104.7	92.7	93.0	97.7	125.2	131.5	128.2	111.3	112.4	111.1	103.3	105.3	102.6	94.0	94.1	98.1
Median SPL	115.8	116.1	114.0	101.8	102.2	101.4	85.9	86.1	86.3	114.3	114.5	112.5	104.9	105.4	104.9	99.7	100.6	99.4	87.7	87.6	87.9
75th percentile SPL	122.5	123.1	120.3	104.9	105.5	104.2	90.1	89.3	89.4	121.7	122.3	119.2	110.0	110.1	109.8	102.6	103.8	102.2	92.0	90.9	91.2
25th percentile SPL	109.8	110.6	109.1	98.9	99.2	98.6	82.9	83.4	83.9	107.7	108.6	107.3	101.0	101.4	100.9	96.7	97.6	96.7	84.0	84.3	84.9
Maximum SPL	150.0	156.1	153.1	139.8	136.8	135.5	128.2	131.5	144.2	149.4	156.1	152.6	144.2	146.4	143.5	138.8	134.9	134.1	129.3	131.7	144.2
Trial																					
Minimum SPL	89.7	92.8	91.2	80.4	80.2	80.2	82.3	82.9	81.7	83.4	85.8	85.8	84.3	83.9	84.0	79.0	78.5	78.2	82.6	83.2	82.0
Mean SPL	130.4	130.6	129.2	104.7	104.6	104.6	94.9	96.2	93.9	130.3	130.5	129.1	111.8	111.4	110.9	102.6	102.5	101.9	97.6	96.8	95.7
Median SPL	116.4	115.6	115.1	99.2	99.1	98.8	84.5	85.5	84.3	115.2	114.5	113.9	104.7	104.3	104.5	97.4	97.1	96.6	85.8	86.9	85.8
75th percentile SPL	124.5	124.0	122.1	102.7	102.4	102.3	87.8	88.6	87.5	124.1	123.6	121.6	109.3	108.8	109.1	100.9	100.6	100.2	89.4	90.4	89.4
25th percentile SPL	110.3	109.6	109.2	95.4	95.4	95.0	83.2	83.8	82.7	108.6	107.9	107.5	100.8	100.4	100.4	93.6	93.4	92.7	83.7	84.5	83.6
Maximum SPL	156.8	157.4	159.1	143.5	140.8	143.1	136.6	139.8	137.4	156.6	157.0	158.9	148.0	148.0	144.9	138.3	139.6	139.6	142.8	139.8	138.4
Post-trial																					
Minimum SPL	92.6	91.8	93.6	83.3	83.0	81.6	83.3	83.5	83.0	85.0	84.4	87.8	84.4	84.4	84.0	81.5	78.8	80.4	83.6	83.8	83.3
Mean SPL	128.8	135.1	135.0	104.5	103.8	104.7	95.2	98.0	93.8	128.7	135.1	134.9	111.3	110.2	110.5	101.5	101.7	102.4	96.2	98.5	95.1
Median SPL	116.8	115.9	120.9	100.4	100.3	100.4	89.1	87.1	87.5	115.8	114.9	120.3	104.1	103.4	103.9	97.9	98.1	98.2	90.6	88.6	89.3
75th percentile SPL	125.2	124.4	130.6	103.5	102.9	103.7	92.1	90.1	90.7	124.9	124.0	130.6	108.9	108.3	108.8	101.0	100.8	101.4	93.8	91.9	92.7
25th percentile SPL	110.7	109.6	113.1	97.3	97.3	97.2	85.0	84.3	84.5	109.4	108.3	112.1	100.3	99.6	99.9	94.6	94.8	94.9	86.2	85.2	85.8
Maximum SPL	154.4	158.2	156.6	140.8	135.1	136.0	135.6	143.1	130.7	154.4	158.2	156.5	144.2	141.4	141.8	136.6	131.6	135.2	135.7	143.1	130.9

With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessel filter**Pre-trial**

Minimum SPL	90.7	92.8	92.7	86.4	82.6	87.3	82.3	82.8	83.3	81.6	89.6	80.9	81.8	84.2	86.2	84.8	80.8	85.4	82.5	83.0	83.6
Mean SPL	124.3	131.3	127.8	104.3	105.6	104.1	90.0	90.7	90.3	124.1	131.2	127.7	111.2	112.2	110.5	102.1	103.4	101.6	91.5	91.9	91.6
Median SPL	114.8	115.7	113.1	101.0	101.7	100.8	84.6	84.6	84.9	113.2	114.1	111.5	104.7	105.3	104.5	98.8	99.9	98.8	86.3	85.9	86.2
75th percentile SPL	120.9	123.0	118.6	104.2	105.0	103.9	88.6	87.9	88.3	120.0	121.9	117.3	110.0	110.1	109.5	101.9	103.2	101.8	90.4	89.4	90.0
25th percentile SPL	108.9	110.1	108.4	98.2	98.7	97.7	82.7	83.2	83.6	107.0	108.2	106.7	100.7	101.2	100.0	96.0	97.0	95.8	83.6	83.9	84.3
Maximum SPL	145.5	156.1	151.3	127.1	128.9	127.1	114.7	121.2	113.0	144.9	156.1	151.1	138.7	138.8	139.4	125.1	128.3	126.1	116.3	121.2	113.6

Trial

Minimum SPL	89.7	92.8	92.1	81.1	80.9	80.5	82.3	82.9	81.7	83.4	88.6	85.9	84.3	83.9	85.7	79.8	78.9	78.3	82.6	83.2	82.0
Mean SPL	128.0	128.6	127.1	102.3	101.2	101.8	92.5	90.6	90.0	127.9	128.5	127.0	110.2	110.0	109.8	100.3	99.0	99.4	93.4	91.8	91.1
Median SPL	114.3	113.8	113.4	97.6	97.2	97.4	83.6	84.2	83.5	113.1	112.8	112.1	103.6	103.0	103.5	95.7	95.0	95.1	84.5	85.2	84.6
75th percentile SPL	121.3	120.7	119.4	101.3	100.4	101.1	86.1	86.9	86.0	120.7	120.1	118.6	108.1	107.3	108.3	99.4	98.4	98.9	87.6	88.4	87.7
25th percentile SPL	108.7	108.3	108.0	93.7	93.6	93.4	83.1	83.6	82.2	107.1	106.8	106.4	99.6	99.3	99.5	91.7	91.3	91.1	83.5	84.1	83.0
Maximum SPL	150.6	154.8	153.8	131.4	134.8	134.4	133.4	122.1	118.9	150.4	154.7	153.8	141.9	146.4	141.1	130.5	132.2	130.4	133.4	122.3	118.9

Post-trial

Minimum SPL	92.6	92.8	94.7	83.3	83.6	81.6	83.3	83.5	83.0	85.3	84.4	88.6	84.4	84.4	84.0	81.5	80.1	80.4	83.6	83.8	83.3
Mean SPL	127.0	134.6	133.0	102.8	102.8	103.3	91.5	92.0	92.7	126.9	134.6	133.0	110.7	109.9	109.7	100.1	100.5	100.8	92.9	93.2	93.8
Median SPL	115.5	114.3	118.4	99.6	99.8	99.4	88.0	86.5	86.8	114.5	113.2	117.7	103.7	102.8	102.8	97.0	97.5	97.2	89.5	87.9	88.5
75th percentile SPL	122.3	121.2	127.1	102.5	102.4	102.6	91.2	89.8	90.1	121.6	120.6	127.1	108.9	107.8	107.9	100.0	100.3	100.4	92.8	91.5	92.0
25th percentile SPL	109.9	108.5	111.3	96.3	96.1	96.3	84.6	84.2	84.1	108.7	107.0	110.3	99.7	98.9	98.7	93.5	93.7	94.1	85.7	84.9	85.3
Maximum SPL	154.1	155.2	154.9	131.2	135.1	135.6	117.1	117.0	121.8	154.0	155.2	154.9	143.2	141.0	139.7	126.6	131.6	135.2	117.5	117.9	122.1

Table 21: The difference in sound pressure levels in decibels (dB re 1 μPa) between pre-trial and trial, and trial and post-trial periods of the frequency ranges of SRKW relevance and representing vessel presence at Jordan River. Environmental restrictions of current less than 0.3 ms^{-1} , wind speed less than 5 ms^{-1} , and small vessels removed for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-Trial to Trial																					
Minimum SPL	-1.0	0.0	-0.6	-5.3	-1.7	-6.8	0.0	0.1	-1.6	1.8	-1.0	5.0	2.5	-0.3	-0.5	-5.0	-1.9	-7.1	0.1	0.2	-1.6
Mean SPL	3.7	-2.7	-0.7	-2.0	-4.4	-2.3	2.5	-0.1	-0.3	3.8	-2.7	-0.7	-1.0	-2.2	-0.7	-1.8	-4.4	-2.2	1.9	-0.1	-0.5
Median SPL	-0.5	-1.9	0.3	-3.4	-4.5	-3.4	-1.0	-0.4	-1.4	-0.1	-1.3	0.6	-1.1	-2.3	-1.0	-3.1	-4.9	-3.7	-1.8	-0.7	-1.6
75th percentile SPL	0.4	-2.3	0.8	-2.9	-4.6	-2.8	-2.5	-1.0	-2.3	0.7	-1.8	1.3	-1.9	-2.8	-1.2	-2.5	-4.8	-2.9	-2.8	-1.0	-2.3
25th percentile SPL	-0.2	-1.8	-0.4	-4.5	-5.1	-4.3	0.4	0.4	-1.4	0.1	-1.4	-0.3	-1.1	-1.9	-0.5	-4.3	-5.7	-4.7	-0.1	0.2	-1.3
Maximum SPL	5.1	-1.3	2.5	4.3	5.9	7.3	18.7	0.9	5.9	5.5	-1.4	2.7	3.2	7.6	1.7	5.4	3.9	4.3	17.1	1.1	5.3
Trial to Post-Trial																					
Minimum SPL	2.9	0.0	2.6	2.2	2.7	1.1	1.0	0.6	1.3	1.9	-4.2	2.7	0.1	0.5	-1.7	1.7	1.2	2.1	1.0	0.6	1.3
Mean SPL	-1.0	6.0	5.9	0.5	1.6	1.5	-1.0	1.4	2.7	-1.0	6.1	6.0	0.5	-0.1	-0.1	-0.2	1.5	1.4	-0.5	1.4	2.7
Median SPL	1.2	0.5	5.0	2.0	2.6	2.0	4.4	2.3	3.3	1.4	0.4	5.6	0.1	-0.2	-0.7	1.3	2.5	2.1	5.0	2.7	3.9
75th percentile SPL	1.0	0.5	7.7	1.2	2.0	1.5	5.1	2.9	4.1	0.9	0.5	8.5	0.8	0.5	-0.4	0.6	1.9	1.5	5.2	3.1	4.3
25th percentile SPL	1.2	0.2	3.3	2.6	2.5	2.9	1.5	0.6	1.9	1.6	0.2	3.9	0.1	-0.4	-0.8	1.8	2.4	3.0	2.2	0.8	2.3
Maximum SPL	3.5	0.4	1.1	-0.2	0.3	1.2	-16.3	-5.1	2.9	3.6	0.5	1.1	1.3	-5.4	-1.4	-3.9	-0.6	4.8	-15.9	-4.4	3.2

During the 2022 and 2023 trial periods, the average distance between tugboats and the Jordan River mooring increased slightly. In contrast, distances remained relatively stable throughout the 2024 trial period (Figure 26). A few outlier tug transits were observed, with vessels passing closer to the mooring than requested.

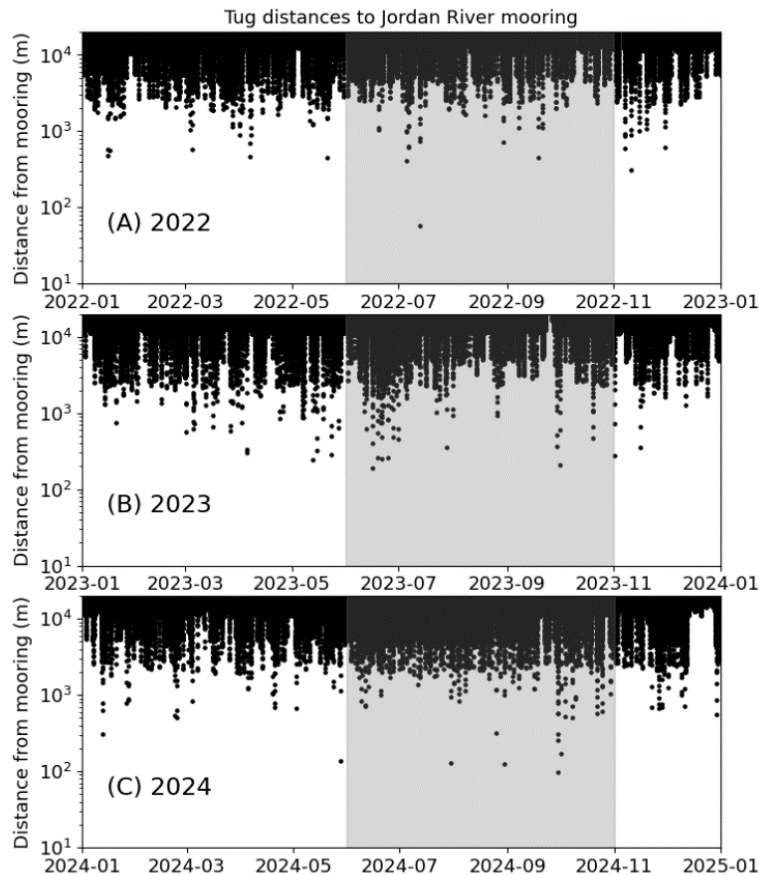


Figure 26 - Tug distances from Jordan River mooring for (A) 2022, (B) 2023 and (C) 2024. Trial period shown by shaded area.

The lack of change in distance between the Jordan River mooring, and the predominant transit route of tugs through Juan de Fuca, resulted in no change overall in the soundscape. Vessel emissions have been observed to be reduced as distance between the source and the receiver increases for tugs (Vagle 2020; Burnham and Vagle 2023), but due to a lack of displacement, this effect was not seen in recordings made in the Strait of Juan de Fuca. In addition, tug transits comprise only a small proportion of the commercial vessels through Juan de Fuca Strait (~10%) and so are not a large contributor to the soundscape overall.

4.3. Interim Sanctuary Zones (ISZs)

The effectiveness of ISZs in reducing underwater noise within SRKW foraging areas is heavily dependent on vessel compliance with zone exclusions. Previous analyses have demonstrated that, paradoxically, the number of recreational vessels tends to increase within these designated zones during trial periods, rather than decrease as intended. This is concurrent to the general increase of recreational vessels present throughout the Salish Sea during the mid-summer months. This trend was originally documented by Burnham et al. (2021), and similar patterns were observed again during the 2022, 2023, and 2024 trial periods (Figure 27), which ran from June 1st to November 30th for all three years.

There is a modest overall downward trend in vessel activity; however, the continued use of these areas (Figure 27) suggests that voluntary exclusion measures and outreach efforts may not be achieving their intended effect. During 2020 and 2021, vessel patterns shifted noticeably because COVID-19 disrupted normal operations and traffic - creating an outlier period in the dataset. These pandemic-related changes temporarily altered vessel behaviour and should be interpreted separately from the broader multi-year trend.

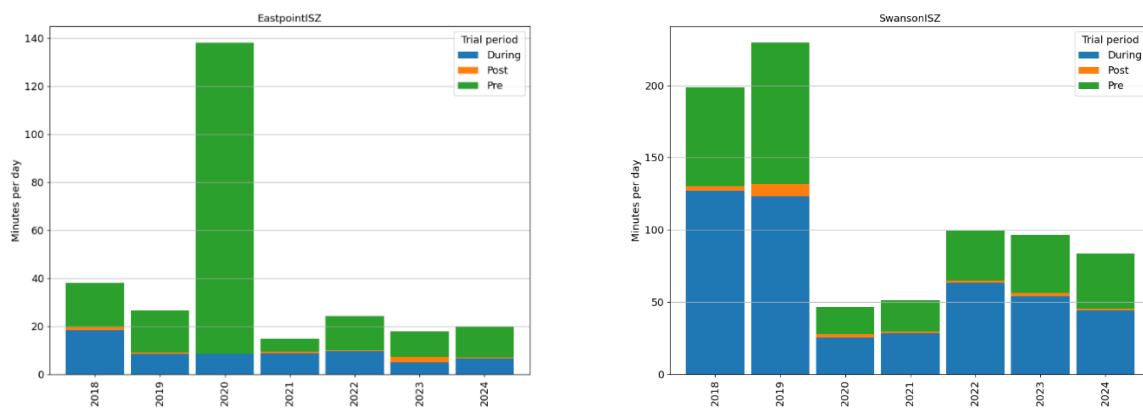


Figure 27: Average number of vessels in East Point ISZ (left) and Swanson Channel ISZ (right) from 2018 to 2024 during the pre-, trial and post-trial periods.

For the purposes of this report, detailed acoustical analysis was limited to the Swanson Channel ISZ. Prior analyses (Vagle, 2020; Burnham and Vagle, 2023) have observed that other ISZs (Saturna and Swiftsure) have and continue to yield limited positive results with little evidence of vessel compliance. The Swanson Channel recording site was selected due to its relatively higher vessel activity, relevance as known SRKW habitat, and its location within the boundaries of the ISZ.

4.3.1. Swanson Channel ISZ

AIS data were used to identify and classify the types of vessels transiting the Swanson Channel ISZ during the implementation period of the measure across the three years studied. The analysis revealed that the majority of vessel traffic consisted of recreational and small passenger vessels, which are typically recorded as Class B AIS signals (Figure 28). It is not mandatory for Class B

vessels to carry AIS, therefore, it is difficult to conclude the actual number of vessels. The numbers presented here represent the minimum. These vessel types represent a significant challenge for mitigation efforts, as they are both numerous and often not subject to the same regulatory scrutiny, or monitoring, as larger commercial vessels. Their continued presence within the ISZ indicates that the current measures may not be sufficiently influencing behavior among this user group, especially during peak boating seasons and that greater enforcement to these mandatory measures is needed.

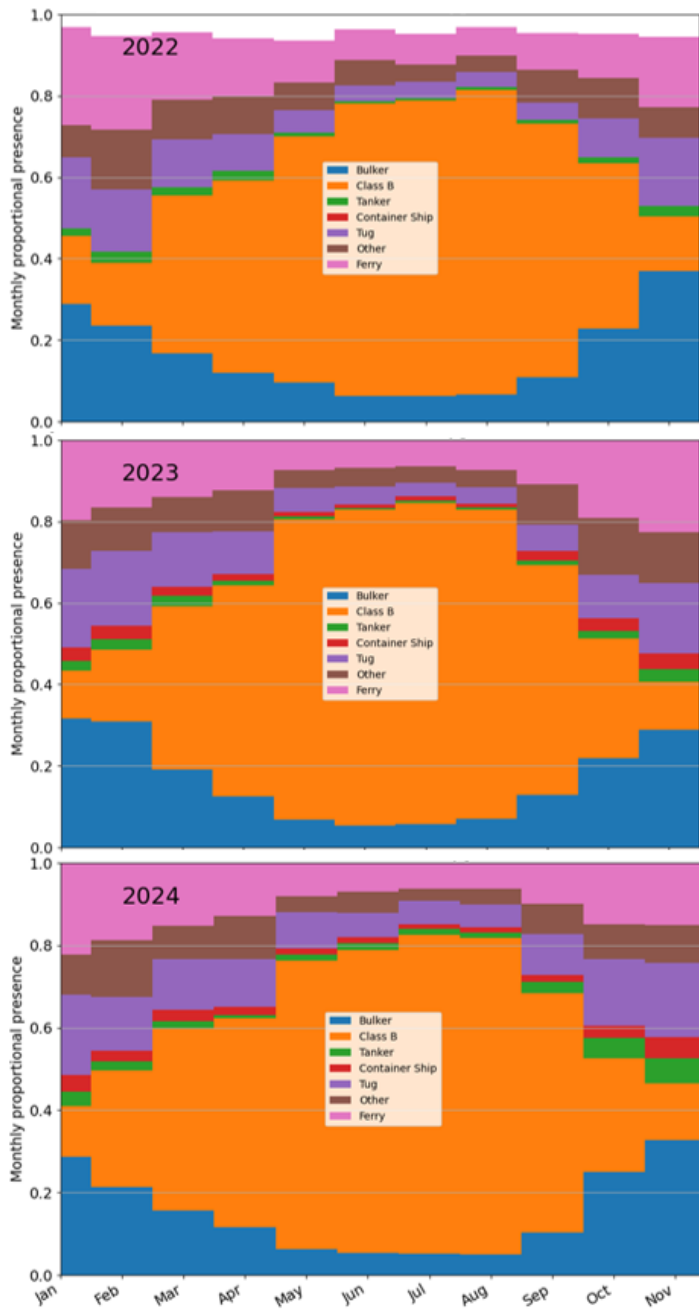


Figure 28: Monthly proportional presence per vessel type within the Swanson ISZ using the number of 5-minute AIS points for all 3 years: 2022 (top), 2023 (middle) and 2024 (bottom). Trials ran from June 1st to November 30th. ‘Other’ category includes passenger, government and naval vessels, as well as any unknown vessels.

During the trial periods, an increase in vessel presence was observed within the ISZ area (Figure 29). This trend is consistent with the typical seasonal rise in recreational vessel activity throughout the Salish Sea during the summer months. A noticeable reduction in vessel numbers coincided with the end of summer (Figure 29).

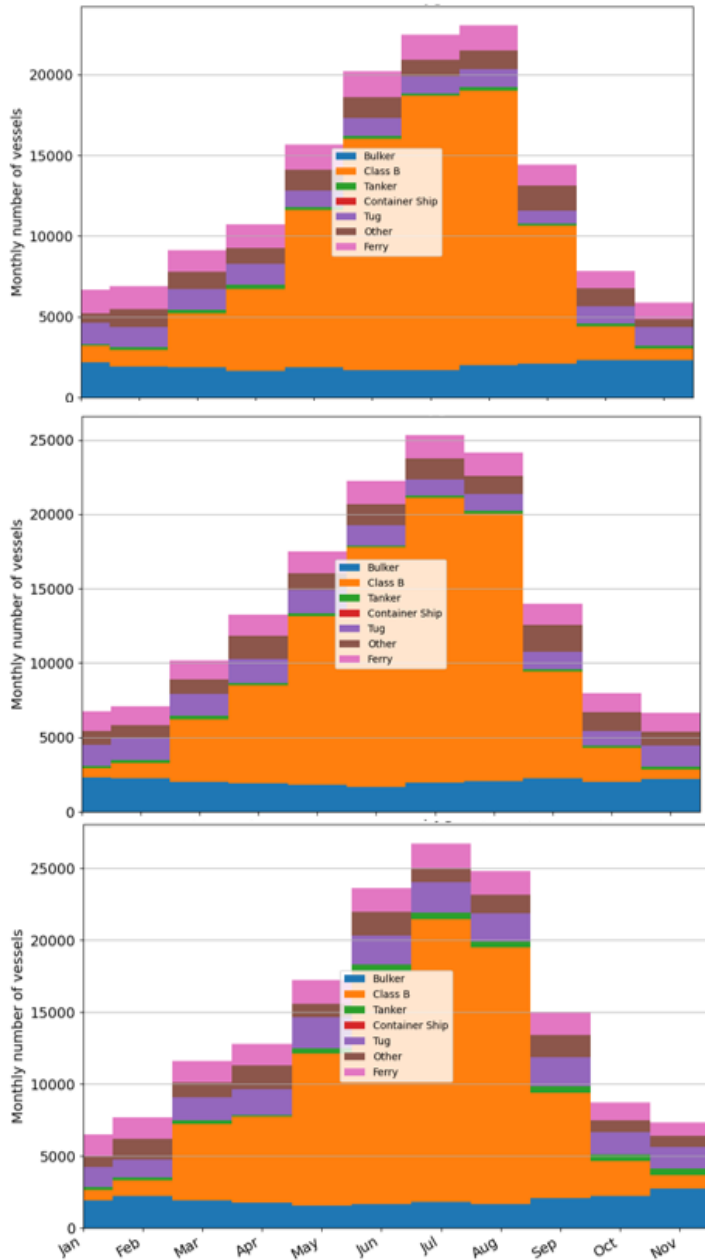


Figure 29: Monthly number of vessels by vessel type within the Swanson ISZ using the number of 5-minute AIS points for all 3 years: 2022 (top), 2023 (middle) and 2024 (bottom). Trials ran from June 1st to November 30th. ‘Other’ category includes passenger, government and naval vessels, as well as any unknown vessels.

Vessel presence and vessel types identified in AIS data reflect the proximity of the ISZ to the shipping lane. AIS records show deep-sea vessels consistently transiting near the ISZ throughout

the trial periods (Figures 30). The commercial vessels may be those transiting Boundary Pass or perhaps to anchorages. Ferries have a constant presence near the Swanson ISZ, as seen in green in Figure 30, perhaps travelling to Otter Bay. The presence of recreational vessels (included in ‘Other’ in Figure 30) was high in the spring, with an increase observed in the summer, and then a sharp decrease after the trial period. Fishing vessel activity corresponded with seasonal fishery openings (Figure 30).

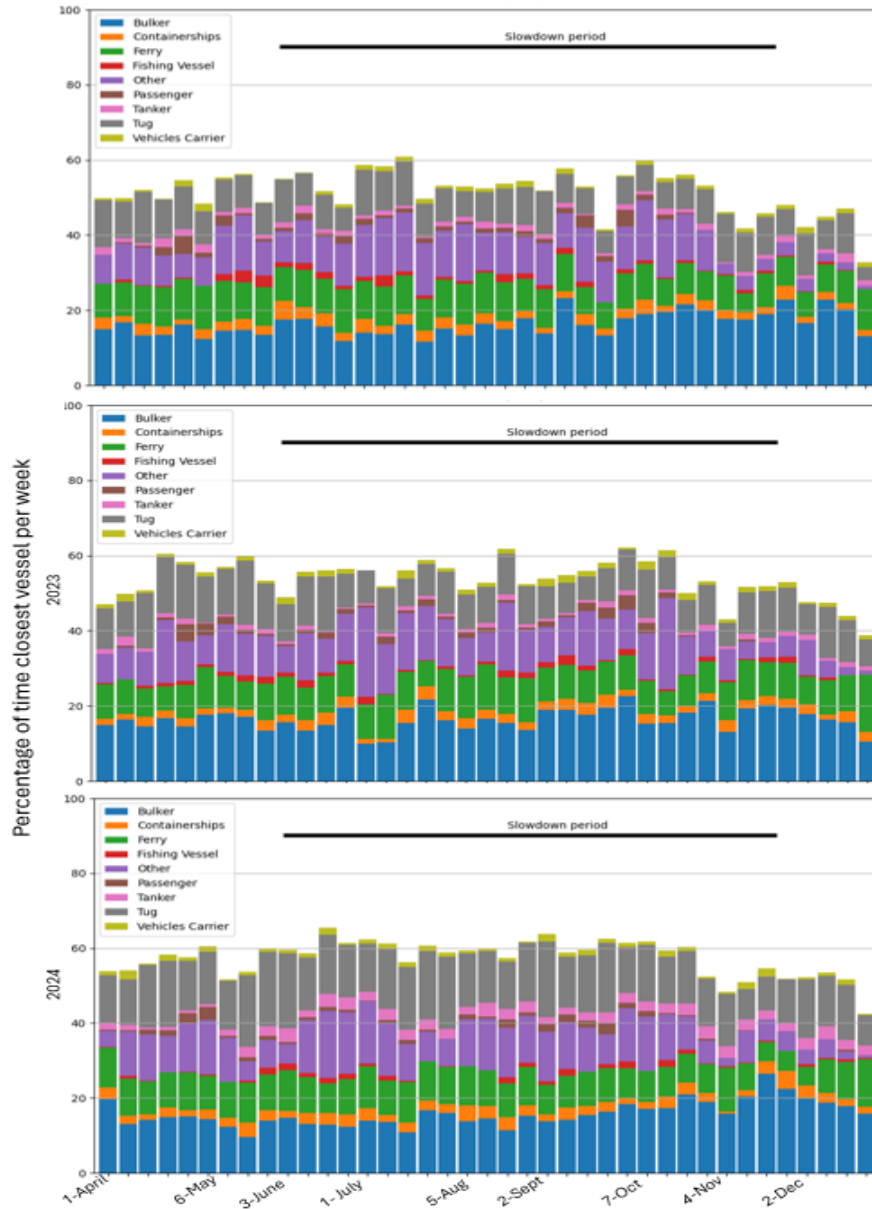


Figure 30: Proportional presence of vessel types established weekly using 5-minute data sections for pre-, during and post-trial periods, with the trial starting June 1st and running until November 30th, 2022 (top), 2023 (middle) and 2024 (bottom) in Swanson Channel ISZ. ‘Other’ category includes recreational, government and naval vessels, as well as any unknown vessels.

To reduce environmental variability, periods with high winds, strong currents, or detected small vessel presence were excluded from the analysis. Table 22 summarizes the number of records removed and those retained.

Table 22: Data segments excluded due to current speeds exceeding 0.3 ms^{-1} , wind speeds above 5 ms^{-1} and small vessel presence for pre-trial, trial and post-trial periods in 2022, 2023 and 2024 for Swanson ISZ. Number of total records remaining after filtering, as well as percent of total number of records remaining.

	Current			Wind			Small Vessel		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
Pre-trial									
Total # records	48643	50441	52250	48643	50441	52250	48643	50441	52250
# of records excluded	6119	4031	3621	4223	14121	10918	6694	6893	7232
% excluded	12.6	8.0	6.9	8.7	28.0	20.9	13.8	13.7	13.8
Trial									
Total # records	146248	103262	162848	146248	103262	162848	146248	103262	162848
# of records excluded	17462	11218	17326	27332	20599	36655	19507	14786	22188
% excluded	11.9	10.9	10.6	18.7	19.9	22.5	13.3	14.3	13.6
Post-Trial									
Total # records	44640	44640	44640	44640	44640	44640	44640	44640	44640
# of records excluded	309	141	98	17133	17805	19081	6435	6514	6117
% excluded	0.7	0.3	0.2	38.4	39.9	42.7	14.4	14.6	13.7
	2022	2023	2024						
Pre-trial									
# of records remaining	33123	28342	33079						
% remaining	68.1	56.2	63.3						
Trial									
# of records remaining	91265	63329	96652						
% remaining	62.4	61.3	59.4						
Post-Trial									
# of records remaining	15104	22279	21829						
% remaining	33.8	49.9	48.9						

In Swanson Channel, vessel passages increased during the mid-summer period from July to September, as shown in Figure 29. Analysis of AIS track data indicated that Class A vessels were infrequently observed within the ISZ (Figure 31), but pass in shipping lanes in Boundary Pass and outside of the exclusion zone in Swanson Channel. In contrast, recreational and Class B vessels did not demonstrate avoidance of the ISZ (Figure 32). Vessels categorized as ‘Other’, including

government and naval vessels, generally navigated around the ISZ. These vessels were, however, frequently observed cutting across its southwestern corner within Swanson Channel, one of which could be servicing of the mooring (Figure 31). Fishing vessels were present but observed only rarely.

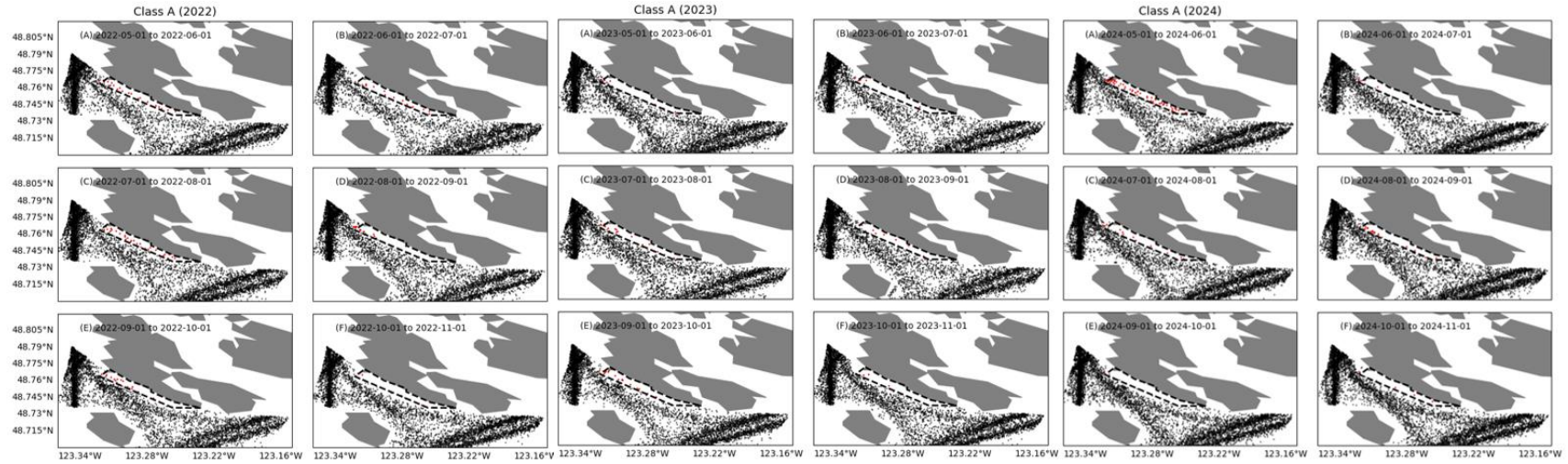


Figure 31: Tracks of Class A vessels passing through the Swanson Channel interim sanctuary zone (ISZ) monthly where (A) is May 1st - 31st, (B) June 1st - 30th, (C) July 1st - 31st, (D) August 1st - 31st, (E) September 1st - 30th, and (F) October 1st - 31st for 2022 (left), 2023 (middle) and 2024 (right). Trials ran from June 1st to November 30th for all three years.

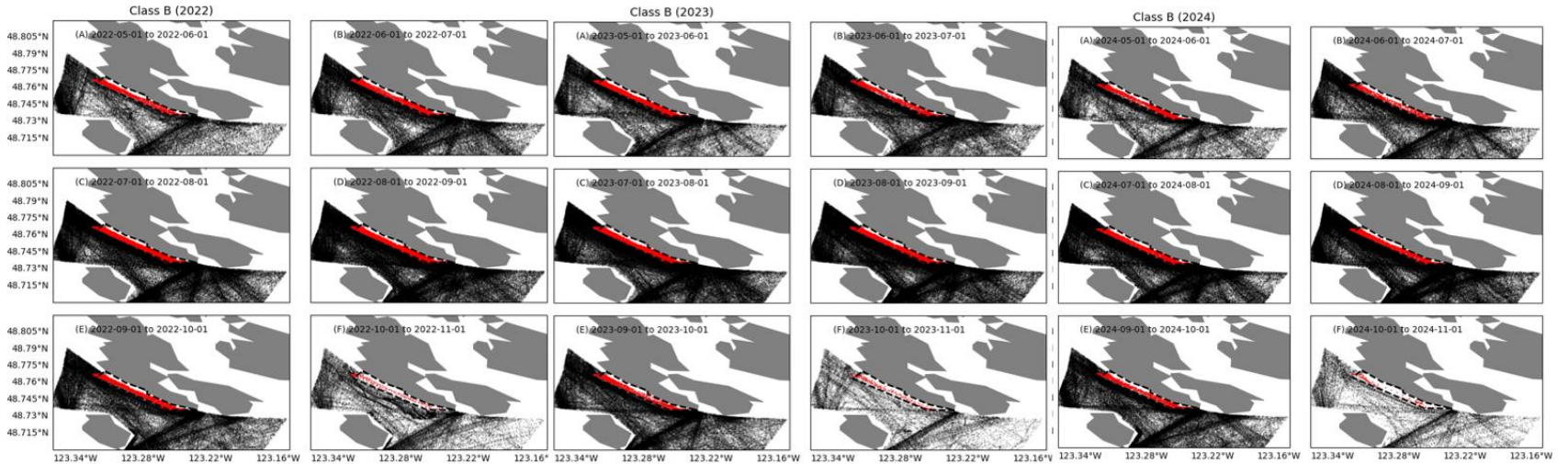


Figure 32: Tracks of Class B vessels passing through the Swanson Channel interim sanctuary zone (ISZ) monthly where (A) is May 1st - 31st, (B) June 1st - 30th, (C) July 1st - 31st, (D) August 1st - 31st, (E) September 1st - 30th, and (F) October 1st - 31st for 2022 (left), 2023 (middle) and 2024 (right). Trials ran from June 1st to November 30th for all three years.

Class B vessels, which typically include recreational boats and smaller passenger vessels, consistently represented the dominant vessel type recorded within the Swanson Channel ISZ across all three years of the study (Figure 31 and 32). AIS data indicate that these vessels accounted for the majority of traffic within the zone, underscoring the persistent challenge of managing smaller, often privately operated vessels in noise-sensitive marine areas.

Analysis of the time spent by vessels within the ISZ on a monthly and daily basis revealed that vessel presence was not limited to a specific time during the period that the measures were in place. While peak activity varied by year, with the highest daily durations occurring in different months across 2022, 2023, and 2024, vessel residency times remained elevated throughout the entire period the measure was in place for each year (Figure 33). This suggests a sustained and widespread level of vessel activity within the ISZ, rather than isolated spikes. This may include recreational fishing activities. The prolonged and repeated presence of Class B vessels in the zone (Figure 34) highlights a potential gap in the effectiveness of voluntary exclusion strategies, particularly during the boating season when recreational traffic tends to increase.

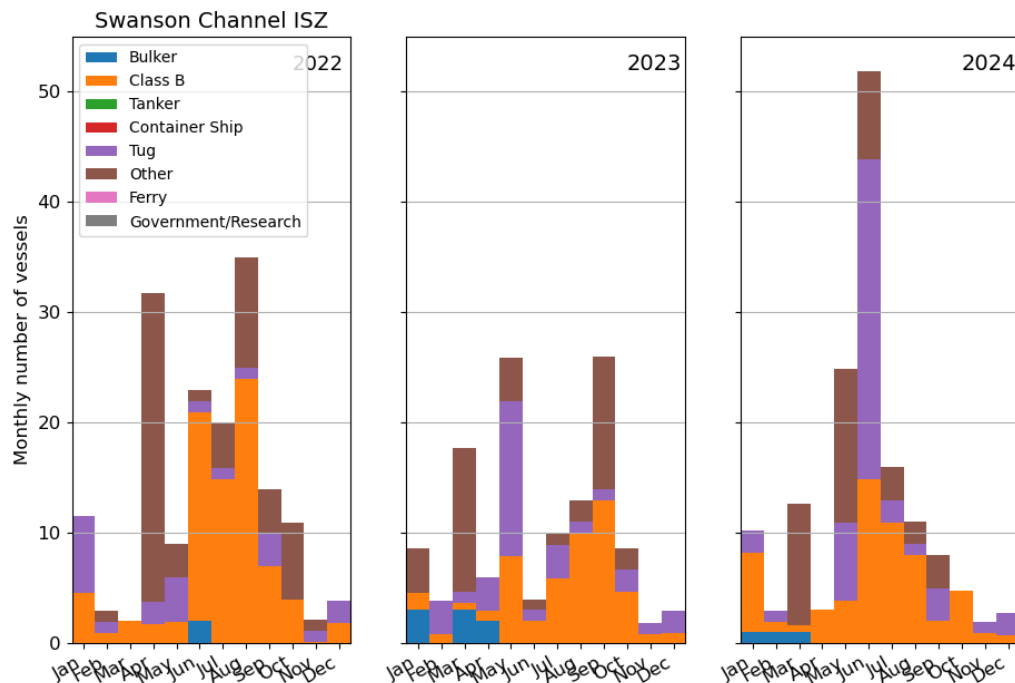


Figure 33: Monthly number of vessels within Swanson ISZ for the entire year of 2022 (left), 2023 (middle) and 2024 (right). ‘Other’ category includes passenger and naval vessels, as well as any unidentified vessels.

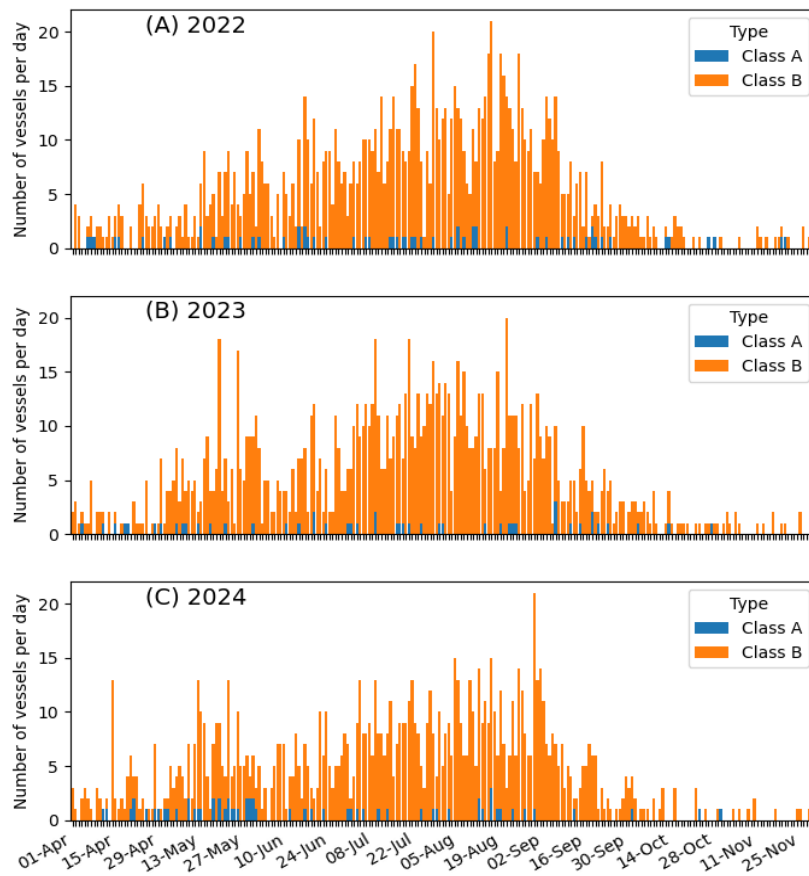


Figure 34: Number of vessels per day within the Swanson Channel ISZ by vessel class in (A) 2022, (B) 2023 and (C) 2024.

Sound levels were analyzed both as recorded and under filtered conditions that excluded environmental factors such as wind and current (Figure 35). Overall, SPL values remained consistent or showed increases from the pre-trial to trial periods (Figure 35). Source attribution using the small vessel detector revealed that commercial vessels from neighboring waters were the still predominant contributors to sound levels, despite the high presence of smaller vessels.

During the trial period, changes in SPLs more often reflected increases than decreases (Tables 23 and 24). While some reductions were observed in higher frequency bands, these same bands showed the largest increases in maximum SPL. Notably, excluding small recreational vessels did not consistently result in SPL reductions, indicating limited acoustic impact from this group despite targeted exclusion measures (Figure 36).

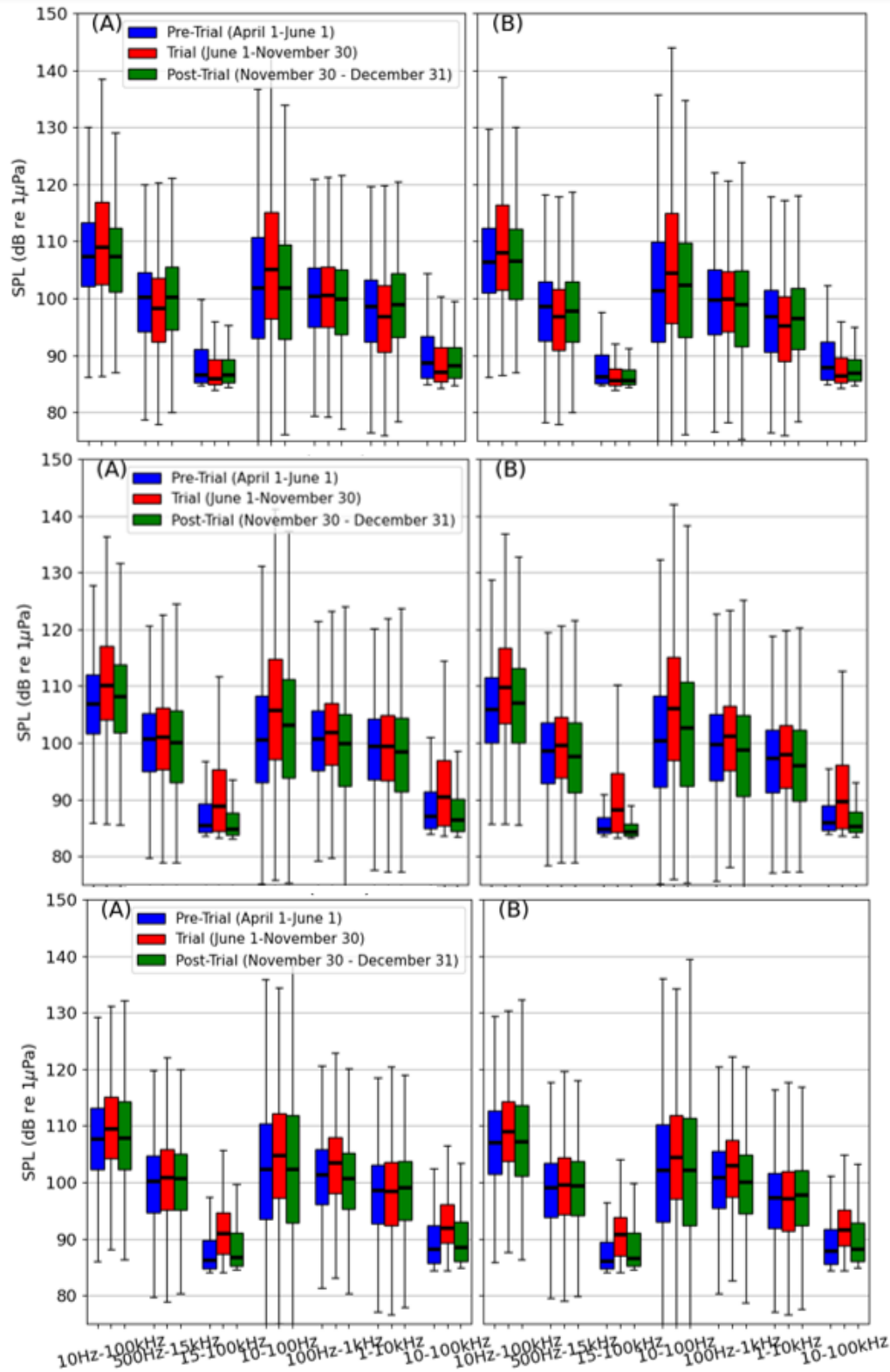


Figure 35: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of interest at the Swanson Channel ISZ as recorded (A) and with the environmental restrictions of current less than 0.3 ms⁻¹, wind speed less than 5 ms⁻¹, and periods indicating the presence of small vessels removed (B) for 2022 (top), 2023 (middle) and 2024 (bottom).

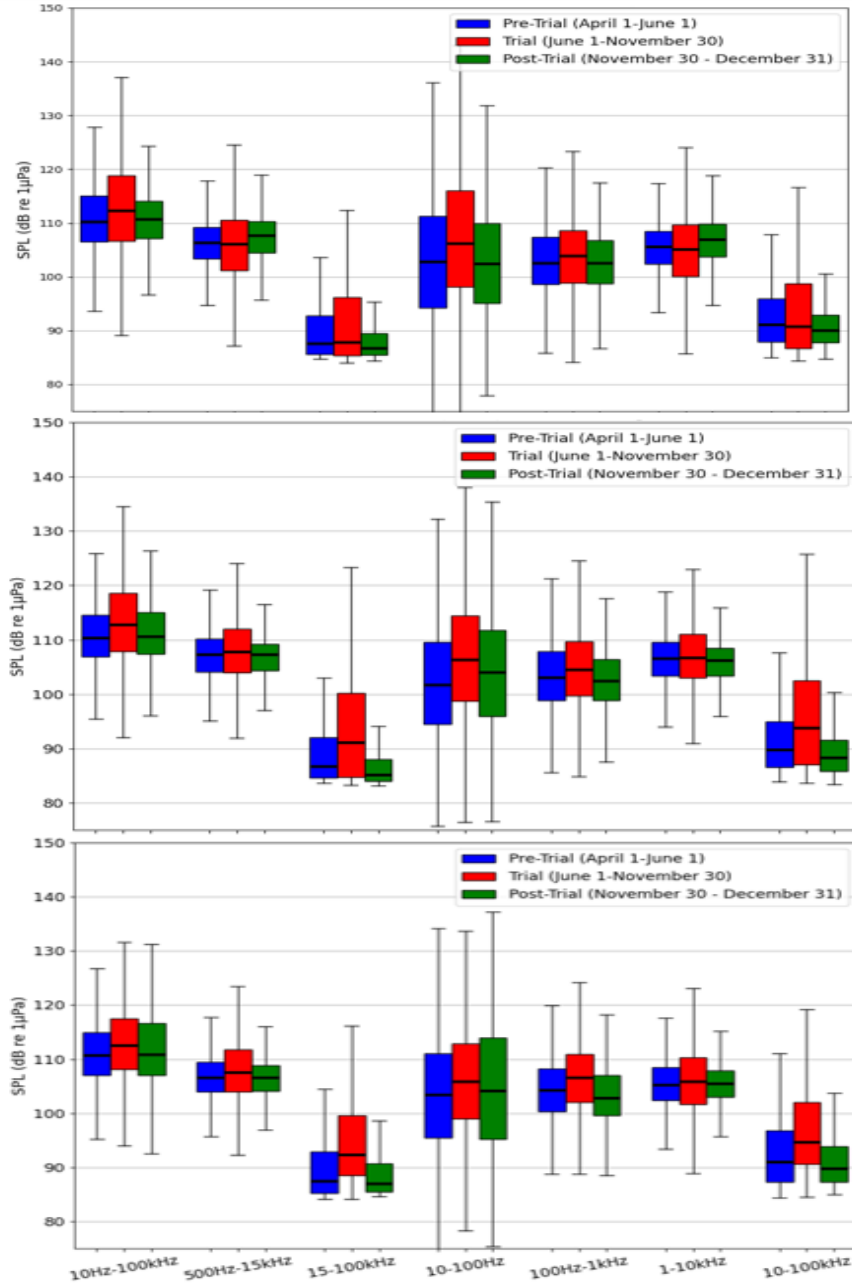


Figure 36: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of interest at the Swanson Channel ISZ for periods when **only** small vessels were present. Restrictions of current less than 0.3 ms^{-1} and wind speed less than 5 ms^{-1} were also applied for 2022 (top), 2023 (middle) and 2024 (bottom).

Table 23: Sound pressure levels (dB re 1 μ Pa) of the frequency ranges of SRKW relevance and representing vessel presence at Swanson Channel ISZ with and without the environmental restrictions (filters) of current less than 0.3 ms⁻¹ and wind speed less than 5 ms⁻¹ with small vessel removed, and then with only small vessels present for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Without Filters																					
Pre-Trial																					
Minimum	86.2	85.8	85.8	78.3	78.4	78.5	84.7	83.7	84.1	72.4	75.2	73.0	73.1	73.4	74.3	76.4	77.1	76.5	85.0	83.9	84.4
Mean	116.9	116.1	120.9	106.4	108.1	107.6	99.5	98.1	99.0	116.1	114.6	120.5	107.5	108.4	108.2	105.0	107.1	106.1	100.4	99.1	100.3
Median	107.4	106.9	107.6	100.1	100.6	100.2	86.6	85.4	86.2	101.8	100.5	102.3	100.4	100.7	101.3	98.5	99.3	98.5	88.7	87.1	88.1
75th percentile	113.3	112.0	113.1	104.5	105.2	104.7	91.1	89.3	89.8	110.7	108.3	110.4	105.4	105.6	105.9	103.3	104.2	103.0	93.3	91.4	92.4
25th percentile	102.1	101.6	102.3	94.2	95.0	94.7	85.2	84.2	84.8	93.1	93.1	93.5	95.0	95.1	96.0	92.3	93.5	92.7	86.0	84.9	85.7
Maximum	140.5	143.8	150.6	137.2	140.9	139.6	139.8	136.6	134.9	139.2	143.8	150.6	136.8	141.5	139.3	136.0	139.7	137.7	139.8	136.6	135.9
Trial																					
Minimum	86.4	85.8	85.9	78.0	78.8	78.6	84.0	83.3	84.1	72.4	75.8	72.8	74.7	75.0	74.9	75.9	77.3	76.5	84.2	83.5	84.4
Mean	126.6	129.4	125.8	109.5	111.7	110.5	102.6	104.4	103.6	126.4	129.3	125.5	109.8	112.0	111.2	108.2	110.3	109.0	103.6	105.6	104.8
Median	108.9	110.1	109.5	98.2	100.9	100.8	85.8	88.8	90.9	105.1	105.8	104.6	100.4	101.7	103.5	96.7	99.4	98.4	87.0	90.5	92.0
75th percentile	116.9	117.0	115.1	103.6	106.1	105.9	89.3	95.3	94.7	115.1	114.7	112.2	105.5	106.9	108.0	102.2	104.8	103.6	91.4	97.0	96.1
25th percentile	102.5	104.1	104.3	92.4	95.2	95.1	84.8	84.4	87.3	96.4	97.1	97.3	95.0	96.0	98.1	90.6	93.4	92.4	85.4	85.3	89.2
Maximum	154.7	156.6	157.4	143.2	142.8	141.6	141.7	139.6	139.2	154.4	156.5	157.4	143.4	146.0	142.6	143.1	142.1	141.4	142.7	140.8	140.5
Post-Trial																					
Minimum	87.0	85.6	86.4	80.0	78.8	79.0	84.4	83.2	84.6	76.2	75.4	72.2	75.3	74.5	75.7	78.4	77.3	76.9	84.7	83.4	84.9
Mean	115.1	122.3	119.4	105.4	106.5	105.5	91.2	92.8	93.2	114.1	122.1	119.0	106.4	107.1	107.2	104.4	104.9	104.0	92.9	94.3	94.8
Median	107.3	108.1	107.8	100.2	99.9	100.7	86.4	84.7	86.6	101.8	103.0	102.3	99.8	99.8	100.6	98.9	98.4	99.0	88.2	86.3	88.4
75th percentile	112.3	113.7	114.2	105.5	105.6	105.1	89.2	87.7	91.0	109.4	111.2	111.8	105.0	105.0	105.2	104.3	104.4	103.7	91.5	90.1	93.1
25th percentile	101.2	101.8	102.2	94.5	93.0	95.2	85.2	83.8	85.3	92.9	93.9	92.8	93.7	92.4	95.3	93.2	91.5	93.4	86.1	84.5	86.1
Maximum	145.8	143.7	142.3	128.7	136.3	133.9	122.7	128.3	123.4	145.8	143.7	142.1	130.0	135.0	130.5	126.4	133.8	133.0	124.4	129.3	123.6

With Filters: U<0.3 ms-1, WSP <5 ms-1, all vessels present**Pre-Trial**

Minimum	86.2	85.8	85.8	78.3	78.4	78.5	84.7	83.7	84.1	72.4	75.2	73.0	73.1	73.4	74.3	76.4	77.1	76.5	85.0	83.9	84.4
Mean	116.1	115.3	120.8	106.6	108.2	107.7	100.2	98.6	99.2	115.0	113.3	120.4	107.7	108.4	108.4	105.2	107.2	106.2	101.0	99.5	100.5
Median	107.1	106.8	107.6	99.7	99.9	100.2	86.3	84.9	86.2	101.4	100.5	102.2	100.1	100.2	101.4	98.1	98.6	98.5	88.2	86.1	88.1
75th percentile	112.8	112.1	113.1	104.3	105.0	104.7	90.4	87.3	89.8	110.1	108.5	110.4	105.4	105.5	105.9	103.0	104.0	103.0	92.8	89.7	92.4
25th percentile	101.7	100.9	102.3	93.6	93.9	94.8	85.2	84.1	84.8	92.7	92.5	93.5	94.5	94.2	96.1	91.6	92.4	92.8	85.8	84.7	85.7
Maximum	140.5	143.8	150.6	137.2	140.9	139.6	139.8	136.6	134.9	139.2	143.8	150.6	136.8	141.5	139.3	136.0	139.7	137.7	139.8	136.6	135.9

Trial

Minimum	86.5	85.8	85.9	78.0	78.8	78.6	84.0	83.3	84.1	72.4	76.0	72.8	74.7	75.0	74.9	75.9	77.3	76.5	84.2	83.5	84.4
Mean	126.3	129.5	125.7	109.3	111.6	110.0	101.9	104.5	102.7	126.1	129.4	125.5	109.6	111.8	110.8	108.0	110.3	108.5	103.0	105.6	103.9
Median	108.6	110.2	109.4	97.8	100.8	100.7	85.6	88.4	90.8	104.7	106.0	104.5	100.3	101.6	103.4	96.3	99.3	98.3	86.6	90.1	91.8
75th percentile	116.8	117.1	114.8	103.1	106.1	105.7	88.3	95.2	94.3	115.1	114.9	112.0	105.4	106.9	107.9	101.8	104.8	103.3	90.5	96.8	95.8
25th percentile	102.1	104.1	104.3	91.9	95.0	95.2	84.8	84.3	87.2	95.9	97.2	97.3	94.7	95.9	98.1	90.0	93.2	92.4	85.3	85.2	89.1
Maximum	154.7	156.6	157.4	143.2	142.8	141.6	138.5	139.6	139.2	154.4	156.5	157.4	143.4	142.8	142.6	143.1	142.1	141.4	142.7	140.8	140.0

Post-Trial

Minimum	87.0	85.6	86.4	80.0	78.8	79.0	84.4	83.2	84.6	76.2	75.4	72.2	75.3	74.5	75.7	78.4	77.3	76.9	84.7	83.4	84.9
Mean	114.1	121.8	119.4	105.4	107.0	105.4	90.5	93.5	93.2	112.9	121.5	119.0	106.4	107.4	107.2	104.5	105.3	104.0	92.4	95.0	94.8
Median	107.5	108.0	107.8	99.5	99.4	100.7	85.7	84.3	86.6	102.3	102.9	102.3	99.7	99.7	100.6	98.3	98.0	99.0	87.2	85.6	88.4
75th percentile	112.6	113.5	114.2	105.1	105.6	105.1	87.6	86.0	91.0	109.9	110.9	111.8	105.3	105.3	105.2	104.1	104.3	103.7	89.8	88.4	93.0
25th percentile	101.1	101.1	102.2	93.6	92.4	95.2	84.9	83.7	85.3	93.6	93.2	92.8	92.6	92.0	95.3	92.2	90.9	93.4	85.6	84.3	86.1
Maximum	143.6	143.7	142.3	127.3	136.3	133.9	122.7	128.3	123.4	143.5	143.7	142.1	127.9	135.0	130.5	125.8	133.8	133.0	124.4	129.3	123.6

With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessels removed**Pre-Trial**

Minimum	86.2	85.8	85.8	78.3	78.4	78.5	84.7	83.7	84.1	72.4	75.2	73.0	73.1	73.4	74.3	76.4	77.1	76.5	85.0	83.9	84.4
Mean	115.7	114.5	120.7	103.8	104.7	104.4	93.2	91.3	92.1	114.9	113.3	120.5	106.6	106.8	107.3	102.3	103.5	102.6	94.8	92.9	94.0
Median	106.4	105.9	107.0	98.5	98.5	99.1	86.1	84.7	86.0	101.2	100.3	102.0	99.7	99.6	100.9	96.8	97.2	97.3	87.8	85.8	87.8
75th percentile	112.4	111.5	112.6	102.9	103.5	103.4	90.1	86.8	89.4	109.9	108.2	110.3	105.0	105.1	105.4	101.5	102.3	101.7	92.3	88.9	91.7

25th percentile	100.9	100.0	101.5	92.6	92.9	93.8	85.1	84.1	84.7	92.4	92.2	93.1	93.7	93.3	95.4	90.5	91.2	91.8	85.7	84.6	85.5
Maximum	139.3	143.8	150.6	129.5	132.3	130.2	120.9	116.3	117.5	139.2	143.8	150.6	131.0	132.6	136.2	128.5	131.0	129.4	121.8	117.3	118.8

Trial

Minimum	86.5	85.8	85.9	78.0	78.8	78.6	84.0	83.3	84.1	72.4	76.0	72.8	74.7	75.0	74.9	75.9	77.3	76.5	84.2	83.5	84.4
Mean	126.1	129.5	125.8	105.7	108.9	107.3	94.5	99.0	97.5	126.0	129.4	125.6	107.8	110.3	109.5	104.3	107.5	105.5	95.8	100.4	98.9
Median	108.0	109.7	108.9	96.7	99.5	99.6	85.5	88.1	90.7	104.5	105.9	104.3	99.8	101.1	102.9	95.1	98.0	97.1	86.3	89.7	91.5
75th percentile	116.4	116.8	114.3	101.7	104.6	104.4	87.7	94.6	93.9	114.9	115.0	111.9	104.8	106.4	107.4	100.3	103.1	101.9	89.5	96.1	95.2
25th percentile	101.4	103.4	103.7	90.9	93.9	94.3	84.7	84.2	87.1	95.5	97.0	97.0	94.2	95.1	97.5	89.0	92.1	91.4	85.2	85.0	88.8
Maximum	153.4	156.6	157.4	135.5	137.0	140.0	132.8	126.8	126.1	153.4	156.5	157.4	136.7	141.4	142.6	135.0	136.9	139.7	132.8	128.6	127.2

Post-Trial

Minimum	87.0	85.6	86.4	80.0	78.8	79.0	84.4	83.2	84.6	76.2	75.4	72.2	75.3	74.5	75.7	78.4	77.3	76.9	84.7	83.4	84.9
Mean	114.0	121.8	119.2	103.8	105.0	104.3	89.1	89.2	92.3	112.9	121.6	118.8	106.3	107.0	107.1	102.7	102.9	102.6	90.7	90.9	94.0
Median	106.4	107.0	107.2	97.8	97.5	99.4	85.6	84.2	86.6	102.2	102.6	102.0	98.8	98.7	100.0	96.5	96.0	97.7	86.8	85.3	88.1
75th percentile	112.1	113.1	113.6	102.9	103.6	103.7	87.4	85.8	91.1	109.8	110.8	111.4	104.9	104.9	104.9	101.8	102.2	102.2	89.3	87.7	92.9
25th percentile	99.8	100.0	101.2	92.4	91.3	94.2	84.9	83.7	85.2	93.2	92.4	92.4	91.6	90.5	94.5	91.0	89.8	92.4	85.5	84.2	86.0
Maximum	143.6	143.7	142.3	121.1	131.2	129.6	106.5	112.2	119.2	143.5	143.7	142.1	127.9	131.2	130.5	119.7	124.3	127.7	108.9	112.3	120.6

With Filters: U<0.3 ms-1, WSP <5 ms-1, small vessels only**Pre-Trial**

Minimum	88.8	89.7	88.9	85.0	85.5	84.7	84.8	83.7	84.1	74.1	75.7	74.0	78.1	74.3	79.2	83.0	84.5	83.7	85.0	83.9	84.4
Mean	118.3	118.4	121.1	112.1	114.5	113.9	107.1	105.6	106.7	116.0	114.0	119.5	110.8	112.9	112.0	110.8	113.6	112.6	107.8	106.5	107.9
Median	110.1	110.4	110.7	106.3	107.2	106.5	87.6	86.6	87.4	102.8	101.7	103.4	102.6	103.0	104.2	105.5	106.6	105.2	91.1	89.8	90.9
75th percentile	115.0	114.5	114.9	109.2	110.2	109.5	92.8	92.0	92.9	111.3	109.6	111.0	107.3	107.8	108.2	108.5	109.5	108.5	95.9	95.0	96.8
25th percentile	106.5	106.9	107.1	103.4	104.1	104.0	85.6	84.6	85.2	94.2	94.5	95.5	98.7	98.9	100.3	102.4	103.3	102.4	87.9	86.5	87.3
Maximum	140.5	142.7	143.3	137.2	140.9	139.6	139.8	136.6	134.9	138.7	137.7	143.3	136.8	141.5	139.3	136.0	139.7	137.7	139.8	136.6	135.9

Trial

Minimum	89.1	88.0	89.1	84.8	84.9	84.9	84.1	83.3	84.1	73.0	76.4	74.3	77.4	79.5	78.4	83.6	84.3	84.1	84.4	83.6	84.5
Mean	127.4	129.5	125.7	116.0	117.4	116.6	110.6	111.6	111.0	126.9	129.0	124.7	114.9	116.4	115.6	114.7	116.1	115.2	111.6	112.7	112.2

Median	112.2	112.7	112.6	106.0	107.7	107.5	87.8	91.1	92.3	106.2	106.3	105.8	103.9	104.5	106.6	105.1	106.7	105.8	90.8	93.8	94.6
75th percentile	118.8	118.6	117.5	110.5	112.0	111.7	96.2	100.2	99.5	116.1	114.5	112.9	108.7	109.7	110.9	109.7	111.0	110.3	98.7	102.5	102.0
25th percentile	106.7	107.9	108.1	101.2	103.9	103.9	85.4	84.8	88.5	98.1	98.7	99.0	98.8	99.8	102.0	100.1	103.0	101.7	86.7	87.0	90.5
Maximum	154.7	155.9	152.0	143.2	142.8	141.6	141.7	139.6	139.2	154.4	155.9	152.0	143.4	146.0	142.3	143.1	142.1	141.4	142.7	140.8	140.5
Post-Trial																					
Minimum	93.5	90.2	90.0	91.1	88.3	87.8	84.4	83.2	84.7	78.0	76.6	75.4	81.1	82.2	81.1	88.7	87.8	84.3	84.8	83.4	85.0
Mean	114.6	122.2	120.4	109.6	110.9	109.3	94.6	98.3	96.2	112.3	121.7	119.9	107.1	108.4	108.0	108.9	109.7	108.2	96.6	99.7	97.9
Median	110.7	110.5	110.7	107.6	107.2	106.5	86.7	85.1	87.0	102.4	103.9	104.1	102.5	102.4	102.7	106.9	106.2	105.4	90.0	88.3	89.8
75th percentile	114.1	115.0	116.7	110.4	109.2	108.9	89.5	88.1	90.8	110.0	111.8	114.0	106.8	106.4	107.0	109.8	108.4	107.9	92.9	91.6	93.8
25th percentile	107.1	107.4	107.0	104.5	104.4	104.1	85.4	84.0	85.5	95.0	95.9	95.2	98.7	98.9	99.5	103.7	103.4	103.0	87.8	85.8	87.2
Maximum	132.4	143.6	137.3	128.7	136.3	133.9	122.7	128.3	123.4	131.9	143.6	137.3	130.0	135.0	130.1	126.4	133.8	133.0	124.4	129.3	123.6

Table 24: The difference in sound pressure levels in decibels (dB re 1 μ Pa) between pre-trial and trial, and trial and post-trial periods of the frequency ranges of SRKW relevance and representing vessel presence at Swanson Channel ISZ. Environmental restrictions of current less than 0.3 ms^{-1} and wind speed less than 5 ms^{-1} with small vessels removed, and small vessels only present for 2022, 2023 and 2024.

Metric	10Hz-100kHz			500Hz-15kHz			15kHz-100kHz			10-100Hz			100-1000Hz			1000-10000Hz			10000-100000Hz		
Year	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024
Commercial Vessels																					
Pre-Trial to Trial																					
Minimum	0.3	0.0	0.1	-0.3	0.4	0.1	-0.7	-0.4	0.0	0.0	0.8	-0.2	1.6	1.6	0.6	-0.5	0.2	0.0	-0.8	-0.4	0.0
Mean	10.4	15.0	5.1	1.9	4.2	2.9	1.3	7.7	5.4	11.1	16.1	5.1	1.2	3.5	2.2	2.0	4.0	2.9	1.0	7.5	4.9
Median	1.6	3.8	1.9	-1.8	1.0	0.5	-0.6	3.4	4.7	3.3	5.6	2.3	0.1	1.5	2.0	-1.7	0.8	-0.2	-1.5	3.9	3.7
75th percentile	4.0	5.3	1.7	-1.2	1.1	1.0	-2.4	7.8	4.5	5.0	6.8	1.6	-0.2	1.3	2.0	-1.2	0.8	0.2	-2.8	7.2	3.5
25th percentile	0.5	3.4	2.2	-1.7	1.0	0.5	-0.4	0.1	2.4	3.1	4.8	3.9	0.5	1.8	2.1	-1.5	0.9	-0.4	-0.5	0.4	3.3
Maximum	14.1	12.8	6.8	6.0	4.7	9.8	11.9	10.5	8.6	14.2	12.7	6.8	5.7	8.8	6.4	6.5	5.9	10.3	11.0	11.3	8.4
Trial to Post-Trial																					
Minimum	0.5	-0.2	0.5	2.0	0.0	0.4	0.4	-0.1	0.5	3.8	-0.6	-0.6	0.6	-0.5	0.8	2.5	0.0	0.4	0.5	-0.1	0.5
Mean	-12.1	-7.7	-6.6	-1.9	-3.9	-3.0	-5.4	-9.8	-5.2	-13.1	-7.8	-6.8	-1.5	-3.3	-2.4	-1.6	-4.6	-2.9	-5.1	-9.5	-4.9

Median	-1.6	-2.7	-1.7	1.1	-2.0	-0.2	0.1	-3.9	-4.1	-2.3	-3.3	-2.3	-1.0	-2.4	-2.9	1.4	-2.0	0.6	0.5	-4.4	-3.4
75th percentile	-4.3	-3.7	-0.7	1.2	-1.0	-0.7	-0.3	-8.8	-2.8	-5.1	-4.2	-0.5	0.1	-1.5	-2.5	1.5	-0.9	0.3	-0.2	-8.4	-2.3
25th percentile	-1.6	-3.4	-2.5	1.5	-2.6	-0.1	0.2	-0.5	-1.9	-2.3	-4.6	-4.6	-2.6	-4.6	-3.0	2.0	-2.3	1.0	0.3	-0.8	-2.8
Maximum	-9.8	-12.9	-15.1	-14.4	-5.8	-10.4	-26.3	-14.6	-6.9	-9.9	-12.8	-15.3	-8.8	-10.2	-12.1	-15.3	-12.6	-12.0	-23.9	-16.3	-6.6

Small Vessels Only**Pre-Trial to Trial**

Minimum	0.3	-1.7	0.2	-0.2	-0.6	0.2	-0.7	-0.4	0.0	-1.1	0.7	0.3	-0.7	5.2	-0.8	0.6	-0.2	0.4	-0.6	-0.3	0.1
Mean	9.1	11.1	4.6	3.9	2.9	2.7	3.5	6.0	4.3	10.9	15.0	5.2	4.1	3.5	3.6	3.9	2.5	2.6	3.8	6.2	4.3
Median	2.1	2.3	1.9	-0.3	0.5	1.0	0.2	4.5	4.9	3.4	4.6	2.4	1.3	1.5	2.4	-0.4	0.1	0.6	-0.3	4.0	3.7
75th percentile	3.8	4.1	2.6	1.3	1.8	2.2	3.4	8.2	6.6	4.8	4.9	1.9	1.4	1.9	2.7	1.2	1.5	1.8	2.8	7.5	5.2
25th percentile	0.2	1.0	1.0	-2.2	-0.2	-0.1	-0.2	0.2	3.3	3.9	4.2	3.5	0.1	0.9	1.7	-2.3	-0.3	-0.7	-1.2	0.5	3.2
Maximum	14.2	13.2	8.7	6.0	1.9	2.0	1.9	3.0	4.3	15.7	18.2	8.7	6.6	4.5	3.0	7.1	2.4	3.7	2.9	4.2	4.6

Trial to Post-Trial

Minimum	4.4	2.2	0.9	6.3	3.4	2.9	0.3	-0.1	0.6	5.0	0.2	1.1	3.7	2.7	2.7	5.1	3.5	0.2	0.4	-0.2	0.5
Mean	-12.8	-7.3	-5.3	-6.4	-6.5	-7.3	-16.0	-13.3	-14.8	-14.6	-7.3	-4.8	-7.8	-8.0	-7.6	-5.8	-6.4	-7.0	-15.0	-13.0	-14.3
Median	-1.5	-2.2	-1.9	1.6	-0.5	-1.0	-1.1	-6.0	-5.3	-3.8	-2.4	-1.7	-1.4	-2.1	-3.9	1.8	-0.5	-0.4	-0.8	-5.5	-4.8
75th percentile	-4.7	-3.6	-0.8	-0.1	-2.8	-2.8	-6.7	-12.1	-8.7	-6.1	-2.7	1.1	-1.9	-3.3	-3.9	0.1	-2.6	-2.4	-5.8	-10.9	-8.2
25th percentile	0.4	-0.5	-1.1	3.3	0.5	0.2	0.0	-0.8	-3.0	-3.1	-2.8	-3.8	-0.1	-0.9	-2.5	3.6	0.4	1.3	1.1	-1.2	-3.3
Maximum	-22.3	-12.3	-14.7	-14.5	-6.5	-7.7	-19.0	-11.3	-15.8	-22.5	-12.3	-14.7	-13.4	-11.0	-12.2	-16.7	-8.3	-8.4	-18.3	-11.5	-16.9

5. DISCUSSION AND CONCLUSIONS

Vessel-generated noise continues to pose a significant threat on the long-term viability of the SRKW population, particularly in key foraging habitats (Weilgart, 2007; Lacy et al., 2017; DFO, 2018, 2021), and that vessel presence and the noise emissions resulting can alter swimming and diving behaviours, including the cessation of foraging (Holt et. al., 2021; Williams et. al., 2009, 2021; Tennessen, et al., 2024). This study evaluated the effectiveness of voluntary vessel slowdowns, tug lateral displacement, and vessel exclusion zones (ISZs) in reducing underwater noise across the Salish Sea from 2022 to 2024. The goal was to lower broadband ambient noise (10 Hz - 100 kHz) and sound levels within SRKW communication (500 Hz - 15 kHz) and echolocation (15 - 100 kHz) frequency bands.

5.1 Vessel Slowdowns

Reductions in SPL at Swiftsure between the pre-trial, trial, and post-trial periods were not consistent across any of the frequency ranges of interest, though the most notable changes occurred in the low to mid-frequencies. The expected decreases in sound levels from the slowdown were likely not observed because many vessels, such as containerships and vehicle carriers, were already operating at or near the requested slowdown speeds (averaged across the large commercial vessels the typical slowdown was about 1 knot). Also, the vessels making a substantial change in speed, in the order of up to 10 knot, were the minority, and comprised a very small proportion of the overall transit number during the trial period. In the future significant changes in SPL are unlikely without more notable reductions in speed by the majority of vessels present and/or the vessels moving further away from the hydrophone, indicative of vessels moving away from foraging areas. Overall, only minimal differences were observed; however, SPLs tended to be elevated during the trial period compared to the pre-trial period, particularly in the higher frequency ranges. Post-trial data showed elevated SPLs under most conditions, regardless of whether data filtering was applied. Elevated lower-frequency noise levels are thought to be as a result of increased fishing vessel presence in the late summer into fall.

In Haro Strait - Boundary Pass, where slightly more significant slows downs were observed (approx. 1 knot for bulkers and tankers and approx. 2.5 knots for containerships and vehicle carriers), a consistent reduction in sound levels was not observed. In fact, increases in SPL were noted across several frequency ranges and metrics considered. Overall, there was no clear pattern across the pre-trial, trial, and post-trial periods. While SPLs were generally elevated during the 2022 trial period compared to the pre-trial phase, the 2023 data showed a contrasting trend, with reduced noise levels during the trial relative to both pre- and post-trial periods, regardless of data filtering. The lack of consistent decreases, or the increases observed, could be attributed to several factors. Slower vessel speeds may result in longer transit and exposure times, and may lead to vessel clustering, particularly in confined waterways like Haro Strait. While slowing down can reduce peak noise levels, this sound energy may shift into lower SPL percentiles, which is why a range of acoustic metrics were considered in the analysis. Each of these were considered in the analysis, and, although none were remarkably elevated, together increased presence of vessels in duration and number may contribute to the overall small changes in sound levels. As with the trial

on Swiftsure Bank, the number of vessels that made substantial changes in transit speed to participate in the slowdown was a small proportion of the overall number.

5.2 Tug Lateral Displacement

Tug traffic exhibited minimal change during the trial periods, consistent with previous observations that most tug transits already occur south of the primary shipping lanes (Vagle & Neves, 2019; Burnham et al., 2021). AIS tracks from 2022 - 2024 show no close approaches to the Jordan River mooring, indicating a natural shift in tug routing rather than a trial-driven behavioral response. Consistent with established transmission-loss relationships, analysis of matched tug transits confirms that received SPLs at the mooring decrease with increasing vessel range. While the literature suggests that maintaining a buffer of approximately 3,000–3,500 m can limit received levels to below behavioral response thresholds for marine mammals (Southall et al., 2007, 2019; NOAA, 2013; Hemmera, 2014), the tug events identifiable in this dataset did not consistently produce SPLs approaching these threshold levels at the mooring. Instead, the received levels associated with tug passages generally remained within the lower end of anthropogenic contributions observed at the site.

5.3 Interim Sanctuary Zones (ISZ)

ISZ compliance in Swanson Channel was low, coinciding with increased vessel presence and longer residence times during summer months. Correspondingly, acoustic measurements showed elevated noise levels across frequency bands relevant to SRKW communication and foraging. Although AIS data substantially underrepresents small vessel activity, these vessels are known to contribute disproportionately to behavioral disturbance and localized acoustic impacts (Williams et al., 2019; Wladichuk, 2021). The removal of small vessels did not alter the primary analysis to the broad-scale, AIS-based quantification of large-vessel noise exposure. In contrast, the disturbance effects attributed to small vessels stem from their behavioral and fine-scale acoustic influence, which is not adequately captured in AIS-derived SPL analyses. Thus, while excluding small vessels may not change the quantitative outcomes of the noise metrics, their ecological relevance - and contribution to disturbance - remains significant.

5.4 Summary

Overall, vessel slowdown trials yielded inconsistent reductions in SPLs across study areas and frequency ranges. At Swiftsure Bank, minimal SPL changes were observed, likely due to vessels already operating near target speeds, while recordings from Haro Strait - Boundary Pass showed no consistent pattern, with some increases in SPL possibly due to longer transit times and vessel clustering. Tug lateral displacement had minimal impact, as most tug traffic already avoids close passes to the lateral displacement area. Swanson Channel ISZ showed low compliance, where increased vessel presence and underreported small craft activity contributed to elevated noise levels, limiting the effectiveness of the sanctuary zone.

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8. APPENDIX

Table 1: Voluntary measures enacted by ECHO in the Salish Sea aiming to reduce SRKW acoustic disturbance 2017-2024. Measures are listed by year and type. Participation rates and the resulting changes in sound levels reported by ECHO and/or DFO Science are given.

Year	Measure	Trial length (days)	Area covered	Participation rate	Ambient noise change	Killer whale presence
2017	Slowdown , Haro Strait (all vessels <11 kts)	Aug 7-Oct 6 (61 days)	16.6 nm	61% (577/951 transits)	-1.1 dB at Lime Kiln, mostly in the low frequencies	SRKW observed on 9 days
	Lateral displacement	Not reported	All vessels	Not reported		
2018	Slowdown (12.5 knots for bulkers, tankers, ferries and government vessels; 15 knots for vehicle carriers, cruise and container vessels)	Jul 12-Oct 31 (111 days)	16.6 nm	87 % reported participation (1467/1678 transits); 77% of vessels within a knot of requested speed	Slow-down: At Jordan River; 1.5 dB Lime Kiln	SRKW observed on 48 days
	Lateral displacement: Deep-sea vessels in outbound and tugs in inbound move southward	Aug 20-Oct 31 (72 days)	34 nm	57% of Deep-seas and 80% (76/122 transits) of tugs spent more the half of transit time in trial zone.	Deep-seas < -1.0 dB; tugs -4.3-5.8 dB in Juan de Fuca	SRKW observed on 11 days
2019	Slowdown (11.5 knots for bulkers, tankers, ferries and government vessels; 14.5 knots for vehicle carriers, cruise and container vessels)	Jul 5-Oct 15 (103 days)	29.6 nm	82% (1279/1551 transits); 67% within a knot of requested speed	Not reported	SRKW sighted on 24 days
	Lateral displacement: Tugs and barge transit shifted southward	Jun 17-Oct 31 (125 days)	28 nm	76% of Tugs spent more the half of transit time in trial zone. Average move of 0.9 nm (93/122 transits)	Jordan River: median broadband: -3.6 dB ~7 dB in broadband ambient noise; 11.5 dB in higher frequencies per tug transit	
	Interim sanctuary zones: Vessel exclusion from areas of Swiftsure Bank,	Jun 1-Oct 31 (153 days)	Not reported	Low compliance	Low compliance	

	Swanson Channel, East Point					
2020	Slowdown: 11.5 knots for bulkers, tankers, ferries and government vessels; 14.5 knots for vehicle carriers, cruise and container vessels for Haro Strait-Boundary Pass and Swiftsure Bank Lateral displacement: Tugs and barge transit shifted southward Interim sanctuary zones: Vessel exclusion from areas of Swiftsure Bank and Swanson Channel, East Point	Haro-Strait, Boundary Pass: Jul 1-Oct 31 (123 days) Swiftsure Bank: Aug 1-Oct 31 (93 days) Jun 1-Oct 31 (153 days) Jun 1-Oct 31 (153 days)	Haro-Strait, Boundary Pass: 29.6 nm Swiftsure Bank: 17-20 nm 28 nm Not reported	Haro-Strait, Boundary Pass: 91% (1803/1980 transits); 68% within a knot of the requested speed Swiftsure Bank 82% (861/1044 transits) 82%. (138/168 transits) Low compliance	Haro-Strait, Boundary Pass: Haro Strait, Median change in 10-100000 Hz: -1.6 dB; 500-15000 Hz: 0.2 dB; 15-100 kHz: 1.3 dB Boundary Pass Median change in 10-100000 Hz: -2.3 dB; 500-15000 Hz: 0.8 dB; 15-100 kHz: 0.7 dB Swiftsure Bank Median change in 10-100000 Hz: -2.0 dB; 500-15000 Hz: -2.0 dB; 15-100 kHz: -4.3 dB Median change in 10-100000 Hz: -1.4 dB; 500-15000 Hz: -1.9 dB; 15-100 kHz: -3.3 dB per transit Swiftsure Bank: 1.8 dB; Saturna Island: 2.2 dB, Swanson Channel: -1.0 dB	Not reported
2021	Slowdown: 11 knots for bulkers, tankers, ferries and government vessels; 14.5 knots for vehicle carriers, cruise and container vessels	Haro-Strait, Boundary Pass: Jul 1-Nov 30 (153 days)	Haro-Strait, Boundary Pass: 29.6 nm	Haro-Strait, Boundary Pass: 90% (2074/2295 transits)	Haro-Strait, Boundary Pass: Haro Strait, Median change in 10-100000 Hz: 1.1 dB; 500-15000 Hz: -0.8 dB; 15-100 kHz: 0.5 dB Boundary Pass Median change in 10-100000 Hz: 2.8 dB; 500-	Not reported

	Swiftsure Bank outbound transits only Lateral displacement: Tugs and barge transit shifted southward Interim sanctuary zones: Vessel exclusion from areas of Swiftsure Bank and Swanson Channel	Swiftsure Bank: Jul 1-Oct 31 (123 days) Jun 1 – Oct 31 (153 days) Jun 1 – Oct 31 (153 days)	Swiftsure Bank 17-20 nm 28 nm Not reported	Swiftsure Bank ECHO reported 81% (total 1624/2010 transits) Measured: 75% 88% (138/168 transits) Low compliance	15000 Hz: -1.3 dB; 15-100 kHz: 0.7 dB ECHO reported: >3 dB, 50% reduction Swiftsure Bank Median change in 10-100000 Hz: 7.3 dB; 500-15000 Hz: -0.8 dB; 15-100 kHz: 0.6 dB Measured per tug, with 2 focal vessels. Up to 10-20 dB reduction dependent on vessel, frequency, and displacement Saturna Island: 3.6 dB, Swanson Channel: 1.2 dB	
2022	Slowdown: 11 knots for bulkers, tankers, ferries and government vessels; 14.5 knots for vehicle carriers, cruise and container vessels Swiftsure Bank Out- and inbound transits Lateral displacement: Tugs and barge transit shifted southward Interim sanctuary zones:	Haro-Strait, Boundary Pass: Jun 1-Oct 31 (153 days) Swiftsure Bank: Jun 1-Oct 31 (153 days) Jun 1- Oct 31 (153 days) June 1-Nov 30 (183 days)	Haro-Strait, Boundary Pass: 29.6 nm Swiftsure Bank 17-20 nm 28 nm Not reported	Haro-Strait, Boundary Pass: 93% (2098/2262 transits) Swiftsure Bank 82% (total 1973 ? 3,565 slower ships? transits) 97% (100/103 transits) Slowdown + displacement: 86% (5700 vessels) Not reported	ECHO reported 2.7-2.8 dB reduction, 47% decrease ECHO reported: 2.2 dB in inbound, 3.1 dB in outbound, 40-50% reduction ECHO reported: 4-7 dB reduction per vessel transit, 60-80% decrease Not reported	SRKW sighted/ Acoustically detected on 40 days

	Vessel exclusion from areas of Swiftsure Bank and Swanson Channel, East Point					
2023	Slowdown: 11 knots for bulkers, tankers, ferries and government vessels; 14.5 knots for vehicle carriers, cruise and container vessels	Haro-Strait, Boundary Pass: Jun 1- Nov 30 (183 days)	Haro-Strait, Boundary Pass: 29.6 nm	Haro-Strait, Boundary Pass: 87% (2442/2800 transits)	Haro-Strait, Boundary Pass: ECHO reports a 3 dB reduction, 50% decreased	SRKW sighted/ Acoustically detected on 36 days
	Swiftsure Bank Out- and inbound transits	Swiftsure Bank: June 1 – Oct 31 (153 days)	Swiftsure Bank 17-20 nm	Swiftsure Bank 86% (3636/4214)	ECHO reported: Preliminary modelling 4.2 dB reduction, 62% reduction	
	Lateral displacement: Tugs and barge transit shifted southward	Jun 1 – Oct 31 (153 days)	28 nm	95% (101/106 transits) Slowdown + lateral displacement: 87%, 6100 vessels	ECHO reported 4-7 dB reduction per tug transit (60-80% reduction) Overall ~18-27% reduction in vessel strike risk Across all slowdown areas & ship types reduction of 14% air emissions	
	Interim sanctuary zones: Vessel exclusion from areas of Swiftsure Bank and Swanson Channel	Jun 1- Nov 30 (183 days)	Not reported	Not reported		
	Seasonal speed restriction zones Swiftsure Bank	Jun 1-Nov 30 (183 days)	Not reported	N/A	N/A	
2024	Slowdown: 11 knots for bulkers, tankers, ferries and government vessels; 14.5 knots for vehicle carriers, cruise and container vessels	Haro-Strait, Boundary Pass: Jun 1- Nov 15 (168 days)	Haro-Strait, Boundary Pass: 29.6 nm	Haro-Strait, Boundary Pass: 86% (2434/2839 transits)	Haro-Strait, Boundary Pass: ECHO reports a 1.8 dB reduction, 34% decrease	SRKW sighted/ Acoustically detected on 40 days
		Swiftsure Bank:	Swiftsure Bank 17-20 nm	Swiftsure Bank 84%	ECHO reports a 3.4 dB reduction,	

	Swiftsure Bank Out- and inbound transits	Jun 1- Oct 31 (153 days)		(3332/3970)	54% decrease (from modelling compared to 2019)	
	Lateral displacement: Tugs and barge transit shifted southward	Jun 1 – Oct 31 (153 days)	28 nm	99% (70/71 transits)	ECHO reported 4-7 dB reduction per tug transit (60-80% reduction)	
	Interim sanctuary zones: Vessel exclusion from areas of Swiftsure Bank and Swanson Channel	Jun 1 - Nov 30 (183 days)	Not reported	N/A	Not reported	