

QUIET SOUND

A Program of Maritime Blue

Best Practices for Passenger-only Ferries Operating in Southern Resident Killer Whale Critical Habitat: A Rapid Review



Photo Credit: Marla Smith via Orca Network

OCTOBER 2025

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Suggested Citation

Adams, S., Banda-Cruz, G., Aronson, R. (2025). *Best Practices for Passenger-only Ferries Operating in Southern Resident Killer Whale Critical Habitat: A Rapid Review*. Seattle, Washington: Maritime Blue.

Background

Southern Resident killer whales (SRKW) are an endangered species that range from British Columbia to California. As of 2025, only 74 SRKW remain. Quiet Sound is a coalition of government agencies, Tribes, maritime businesses, conservation groups, and ports that seeks to mitigate the impacts of commercial vessels on these endangered orcas. Vessel presence can harm SRKW through physical disturbance and noise pollution, which disrupts the whales' ability to hunt, communicate and rest. Notably, passenger-only ferry vessels operate at speeds up to 30 knots, posing a strike risk to orcas. Underwater noise and potential whale-strike risks were identified as concerns in the [Governor's Orca Task Force report](#) (Southern Resident Orca Task Force, 2019). The [Puget Sound Passenger-only Ferry Study](#) noted that operating protocols to reduce risks to marine mammals were put in place by existing passenger-only ferry operators and would be needed for any future routes (Puget Sound Regional Council, 2021).

In response to a growing interest in increasing passenger-only ferry capacity in Washington, and the introduction of HB 1923 ('Mosquito Fleet bill'), Quiet Sound researched best practices for safer operation of passenger-only ferries in Southern Resident killer whale (SRKW) critical habitat, informed by current practices of Washington passenger-only ferry operators, ferry operators around the world, and the best available science. The audiences for this document include:

- Potential future operators of passenger-only ferries
- Current operators of passenger-only ferries
- Legislators and regulators
- Members of the public

The greatest opportunities to reduce a vessel's underwater radiated noise occur in the design phase (Noise Control Engineering, 2025). Ship owners can articulate URN limits for vessel specifications during the design phase using the SNAME Technology & Research Bulletin 6-3. The Vard matrix highlights technical and operational measures to reduce underwater radiated noise for new builds and retrofits across different vessel categories (Vard, 2023). However, each measure has its own respective disadvantages, benefits and costs, and therefore must be considered holistically rather than piecemeal to maximize impact and minimize tradeoffs.

Methodology

Key Informant Interviews

Quiet Sound developed a conversation guide to inform engagement with current passenger-only ferry operators with service in Washington waters. Quiet Sound interviewed personnel from the following passenger-only ferry operators from March through May 2025:

- Kitsap Transit Fast Ferries
- King County Water Taxi
- FRS Clipper Ferry

Quiet Sound thanks these operators for their commitment to safe operations around whales and their willingness to take the time to inform this product.

Literature Review

A rapid review was conducted to collect best-available science on reducing the impact of passenger-only ferries and similarly-sized vessels on marine mammals.

Findings

Washington's current passenger-only ferry operators are well-informed about safe practices in SRKW critical habitat and can serve as a resource to guide newer operators in the future.

Passenger-only ferry personnel onboarding includes training regarding what to do in the presence of whales. Many operators are very experienced with recognizing whale behavior. One operator shared their Standard Operating Procedure for whale safety. Operators were interested in the [Whales in Our Waters training](#) offered online by the ECHO Program.

Regulations are posted in personnel gathering spaces. Two operators conduct a whale briefing before transits. This includes weekly captains meetings and calling Puget Sound VTS before each transit. The operator that did not have a formal pre-transit whale checklist was interested in developing one.

All operators have one crew on watch in addition to the captain at all times. Some operators use technology to support watches, while others do not find them effective. One operator uses a [FLIR](#) thermal imaging camera to detect whales and submerged objects at night. Another operator uses night-vision binoculars in addition to putting infrared emitters on their vessels to increase visibility.

Personnel often learn of whale presence from other personnel (radioing internally) or informal social media networks. The Pacific Whale Watch Association (PWWA) app is used more often than [Whale Report](#) by passenger-only ferry operators. This may be explained by the number of ferry personnel who have previously worked for a whale watching outfitter. Quiet Sound helped set up accounts for passenger-only ferry personnel who did not have access to Whale Report and expressed interest. Personnel report sightings to the Cetacean Desk, Whale Report, and Whale Alert especially if whales are near vessel traffic lanes. Some personnel will radio commercial vessels if they are near a whale. There was some confusion around the difference between Whale Report, Whale Alert, and Facebook groups.

Personnel try to steer clear of SRKWs to avoid having to reduce their speed if within 1000 yards. They prefer to deviate their route than reduce their speeds, but they can reduce down to or below 7 knots. Most passenger-only ferry vessels typically transit at 28-30 knots.

One operator is [Green Marine](#) certified. Other operators were interested in certification.

One operator utilizes a robotic hull cleaning device ([Hullbot](#)) every two weeks, primarily to reduce fuel consumption but also likely reducing underwater radiated noise (URN) by reducing the effort the engine needs to move the vessel through water. Operators also aim to reduce the overall weight of the boat to reduce fuel consumption.

Several operators are interested in their fleet's underwater noise signature. One operator has had their noise signature analyzed by [Noise Control Engineering](#). Some vessels use jet propulsion while others have fixed-pitch propellers.

Some operators are considering adding new vessels to their fleet and were open to considering URN in the design, as well as noise reduction technologies endorsed by the [Port of Vancouver's EcoAction program](#). Energy efficiency is a priority for them.

An annotated bibliography including literature covering: International, national, and regional best practices, existing regulations and guidelines for the Salish Sea, applicable targets and strategies, operational measures, noise signature and quieting technologies and whale detection and alert technologies is included in this report.

For Passenger-only Ferry Operators: Best Practices for Safer Operations Near SRKW

Know the rules, have a plan, be whale-aware, assess your impact, design for the future.

KNOW THE RULES: Understand Regulations and Learn About Whale Behavior

- Complete the [Whales in Our Waters](#) training.
 - Integrate into new personnel onboarding; make it required for existing personnel.
- Know the applicable state SRKW approach regulations¹ (RCW 77.15.740, effective Jan 1, 2025); post them in personnel gathering spaces, such as breakrooms and bridges.
 - Within 1000 yards (approximately ½ nautical mile): Do not approach.
 - Between 1000 and 400 yards: Attempt to navigate out of path and reduce speed to 7 knots or less.
 - Within 400 yards: Disengage transmission.
 - Vessels are exempt from these rules when operating in conjunction with a vessel traffic service and following a traffic separation scheme; or complying with a VTS measure of direction.
- Have Quiet Sound or Soundwatch present to your captains and personnel to learn about SRKW, how they use their habitat, how to spot them, and how best to safely avoid them.
- See Appendix A for commercial whale watchers seeking to operate as a passenger-only ferry.

HAVE A PLAN: Define and Implement Operational Measures to Reduce Underwater Noise Impact and Strike Risk

- Ensure all personnel have access to the [Whale Report, sometimes also called the Whale Report Alert System \(WRAS\)](#)². Check Whale Report before every transit to gauge likelihood of sharing waters with whales.
- Include whale sightings debriefs during shift turnover.

¹ If a passenger-only ferry advertises marine mammal viewing or engages in marine mammal viewing, the commercial whale watching requirements in RCW 77.15.740 and WAC 220-460 would apply.

² Quiet Sound recommends that commercial mariners use Whale Report. It is a real-time whale tracking app designed primarily for commercial mariners, and it is available on Portable Pilot Units, a smartphone app, text and /or email alerts, and a browser version. It is the tool of choice for commercial mariners on both the US and Canadian sides of the vessel lanes of the Salish Sea. Other options: Whale Alert is primarily for the public and recreational boaters, and the Pacific Whale Watch Association app is primarily for commercial whale watchers and has the most data in areas frequented by those businesses.

- Develop an underwater noise (and strike risk) mitigation plan or Standard Operating Procedure that includes when to stay at dock, when to slow, and when to use an alternate route if whales are nearby (i.e., [Washington State Ferries Marine Mammal Management Plan](#)).
- Demonstrate commitment to setting and meeting targets through achievement of [Green Marine certification and advancement through levels](#).
- Ensure regular hull cleaning and maintenance. Periodically inspect the propeller for any dents, pitting, or marine growth to maintain its performance and efficiency. Be sure to address any damage or fouling to restore the propeller's smooth surface and reduce cavitation.

BE WHALE AWARE: Report Whale Sightings, Improve Whale Detection Capabilities, and Receive Whale Alerts

- If cellphones are allowed on the bridge, ensure personnel have access to [Whale Report](#) to understand real-time whale presence while on the water.
- Have at least one crew on watch for whales at all times, and two during periods of high likelihood of whale encounter.
- Use sensing technology to help the watch, including but not limited to:
 - Vessel-mounted thermal camera, showing feed in bridge and ideally reporting to Whale Report. A thermal camera does not require emitters.
 - Passive Acoustic Monitoring (PAM) with a hydrophone.
 - Infrared or thermal binoculars to detect whales. Note that the infrared night vision option works reliably only with infrared emitter bars on vessels.
- Report all whale sightings via [Whale Report](#) or radio into the USCG Cetacean Desk (ch. 5A, 14).
- Inform other commercial vessels of whale sightings in the vicinity.
- Ask your ECDIS vendor about integrating Whale Reports alerts through their API.
- Promote comprehensive training and awareness:
 - Provide regular, thorough training to personnel on the operational capabilities and limitations of whale detection technologies.
 - If using fully automated detection systems aided by AI, maintain a human oversight component to verify alerts. This practice is crucial for building and sustaining mariner trust in the technology, preventing alert fatigue and ensuring that every notification receives due attention.
- Contribute to regional whale protection programs by lending staff expertise, sharing whale location data, or financially supporting these programs.

ASSESS YOUR IMPACT: Understand Your Fleet's Noise Signature and Relevant Quieting Measures (Operational or Technological)

- Assess the underwater noise signature of vessels in your fleet to identify primary causes of URN and subsequent appropriate strategies to address them. Articulate these strategies in an Underwater Noise Mitigation Plan.
- Obtain an underwater noise notation from a classification society.

- Explore noise reduction technologies endorsed by the [Port of Vancouver's EcoAction Program](#).
- Periodically evaluate the vessel's URN to evaluate approaches.

DESIGN FOR THE FUTURE: Prioritize Underwater Radiated Noise Reduction in Vessel Design and Retrofits

- When designing or procuring a new vessel, identify URN limits in their vessel specifications. To develop a limit, refer to the Society of Naval Architects and Marine Engineers (SNAME) Technology & Research Bulletin 6-3. Owners can work with an acoustician and/or classification society.
- Consider URN reduction as early in the design process as possible. While many design strategies that reduce URN also improve energy efficiency, not all do. Vessel owners and ship designers can refer to the matrix of technological and operational measures to reduce underwater radiated noise and understand their relative benefits, challenges, and costs (Vard, 2023).
- Choose lighter vessels or lighter internal components (such as seats).
- Improve route planning to increase efficiency (put more people in fewer transits).

Annotated Bibliography

International Best Practices

1. International Maritime Organization. (2023). Revised Guidelines for the Reduction of Underwater Radiated Noise from Shipping to Address Adverse Impacts on Marine Life. MEPC.1/Circ.906.
[https://wwwcdn.imo.org/localresources/en/Documents/MEPC.1-Circ.906%20-%20Revised%20Guidelines%20For%20The%20Reduction%20Of%20Underwater%20Radiated%20NoiseFrom%20Shipping%20To%20Address...%20\(Secretariat\).pdf](https://wwwcdn.imo.org/localresources/en/Documents/MEPC.1-Circ.906%20-%20Revised%20Guidelines%20For%20The%20Reduction%20Of%20Underwater%20Radiated%20NoiseFrom%20Shipping%20To%20Address...%20(Secretariat).pdf)

The IMO's revised guidelines encourage URN management planning to begin at the earliest design stage as possible. Strategies outlined to reduce URN include:

- Design considerations, such as hull forms and propeller designs to reduce cavitation;
- Wake flow improvement techniques;
- Minimizing structure-born noise of machinery through proper installation and isolation;
- Maintenance practices such as propeller polishing and hull cleaning;
- Optimizing trim to lower power requirements and reduce cavitation;
- Voyage planning to avoid sensitive areas and improve efficiency; and
- Reducing ship speed, especially below cavitation inception speed.

The guidelines note that while regulatory obligations for energy efficiency must take precedence over URN reduction measures, co-designing the hull and propeller can both enhance energy efficiency and reduce noise.

Finally, it provides a template for an underwater radiated noise management plan, including baselining, setting targets, implementation approaches, and monitoring and evaluation.

2. International Whaling Commission. (2022). *Strategic Plan to Mitigate the Impact of Ship Strikes on Cetacean Populations: 2022-2032*.
<https://archive.iwc.int/pages/download.php?direct=1&noattach=true&ref=19858&ext=pdf&k>


This is the International Whaling Commission's Strategic Plan to Mitigate Ship Strikes, published in March 2022. Objectives include: summarizing current literature and maintaining global ship strike database, identify high-risk populations, understand relationship between vessel speed and injury risk, increase the application of measures that reduce collision (re-routing, speed reduction), improve reporting of incidents to the IWC ship strike database, increase development and use of avoidance technologies (infrared, auto-detection buoys, predictive modelling, real-time reporting, passive acoustics), and education and avoidance training. SRKW are not one of the high-risk or at-risk whale species listed.

3. Cates, K. et al. (2017). *Strategic Plan to Mitigate the Impacts of Ship Strikes on Cetacean Populations: 2017-2020*.
https://www.researchgate.net/publication/324213676_Strategic_Plan_to_Mitigate_the_Impacts_of_Ship_Strikes_on_Cetacean_Populations_2017-2020

This is a technical report developed to inform the IWC's strategic plan to reduce ship strikes. It highlights ongoing work, anticipated research, and recommendations to reduce ship strikes. Authors acknowledge that reducing the spatial overlap of whales and vessels is the best way to reduce ship strikes. Second best is vessel speed reductions.

Recommendations for training and technology to reduce strike risk include:

- Conducting avoidance training for pilots:
 - The U.S. National Park Service was working with ship pilots to simulate detection and practice avoidance maneuvers using a full bridge simulator. The goal was to develop guidelines for pilots that reduce strike risk while also appreciating operational constraints (Note: These are not publicly available). The plan recommends training curriculums are paired with simulators (i.e. SEAiq) and be tailored to the species at risk and local pilotage.
- Co-operating with the whale watching industry:
 - Whale SENSE is a voluntary program offered to commercial whale watching programs in the U.S. Atlantic and Alaska. It is run by NOAA and the Whale and Dolphin Conservation organization.
- Detection technology:
 - The plan recommends the following be evaluated for efficacy: infrared blow detection, auto-detection buoys, predictive modeling, passive acoustics, and real-time reporting applications.
- Applications to support operations and voyage planning:
 - Whale Alert

4. Song, Kyung-Jun. (2013). *Potential collision risks of large whales and fast ferries traveling between Korea and Japan*. Journal of Marine Animals and Their Ecology. 6(1).
https://jmate.ca/wp-content/uploads/2020/12/BriefCommunication_SongGalley.pdf

This was a study of the overlap of incidental whale sightings along a fast ferry route between Korea and Japan from 2007-2009. It identified spring as a period of higher whale presence (Minke, North Atlantic right whale, western gray whale). The researcher noted the lack of species data was likely due to vessel operator lack of education on cetaceans and therefore recommended educated mariners. The following measures were recommended:

- Limit vessel speed/ change sailing routes
- Develop whale detection methods.
- Aircraft and vessel sighting surveys
- Establish a call center to exchange information on cetacean occurrences
- Education crews of fast ferries
- Make a mandatory ship strike reporting system

National Best Practices

1. Fisheries, N. (2023). *How to Safely Operate Your Vessel Around Whales* | NOAA Fisheries. NOAA.
<https://www.fisheries.noaa.gov/feature-story/how-safely-operate-your-vessel-around-whales>

This webpage provides guidance for recreational boaters and fisherman navigating near whales and for whale watchers particularly in the New England/Mid-Atlantic region. Recommendations include:

- Complete the [See a Spout? Watch Out](#) (recreational) boater education program.
- Ensure compliance with federal law, particularly in respect to approach laws for the North Atlantic right whale.
- Alert other nearby boats via VHF radio (Ch 9 or 16).
- Know the signs that a whale might be present/surfacing.
- Call NOAA's stranding hotline if a whale is in trouble (866) 755-6622.
- Report whale sightings and receive alerts about whale management areas through the Whale Alert app.

Regional Best Practices

1. Washington State Ferries. (2021). *Washington State Ferries Underwater Noise Mitigation and Management Plan for the Protection of Marine Mammals*.
<https://wsdot.wa.gov/sites/default/files/2021-12/WSF-Environment-MarineMammalManagementPlan.pdf>

Washington State Ferries published their Marine Mammal Management Plan in December 2021 to meet the underwater noise criteria for their Green Marine certification. Actions that WSF is taking:

- Contracted with Noise Control Engineering to understand the noise profiles of their vessels, main sources of underwater radiated noise, and sound propagation from ferry terminals.
- Their policy states that vessel crews are required to report whale sightings to the WSF Operations Center, who then report to Whale Report. The Operations Center also monitors Whale Report for whale detections near WSF vessels. In 2019 and 2020, WSF provided over 200 sighting reports to Whale Report.
- Within ½ nautical mile of a marine mammal, WSF vessels slow to seven knots SOG. Within ¼ nautical mile of a marine mammal, WSF vessels do not approach, do not position in the path, and disengage the engine.
- WSF vessel crews are required to take the 'Whales in our Waters' training. It has been incorporated as part of new crew member onboarding.
- When new vessels are commissioned, WSF incentivizes builders to implement noise reduction design notations, such as SILENT-E from DNV. WSF will incentivize quiet propeller designs for the 16 new vessels planned for their fleet over the next two decades.

2. Puget Sound Regional Council. (2021). *Puget Sound Passenger-Only Ferry Study*. <https://www.psrc.org/our-work/puget-sound-passenger-only-ferry-study>

Operating protocols are in place to mitigate impacts to Southern Resident killer whales for all currently operating passenger-only ferries in Puget Sound. Any new passenger-only vessel services would need to adopt and customize those protocols. The report identifies technologies that can help POF reduce underwater noise, specifically special propellers and the use of water jet propulsion.

3. Governor's Orca Salmon Recovery Office, Puget Sound Partnership. (2022). *Potential Mitigation Options to Address the Supplemental SEPA Checklist for Southern Resident Orcas*. <https://orca.wa.gov/wp-content/uploads/SEPAmitigationOpportunities.pdf>

The Governor's Salmon Recovery Office and Puget Sound Partnership developed supplemental mitigation options for [SEPA agencies](#) to mitigate impacts and implement best practices for Southern Resident orcas. These include:

- Hiring licensed Puget Sound Pilots who use Whale Report to improve situational awareness of whale location.
 - Participate in voluntary slowdowns like those administered by ECHO and Quiet Sound.
 - Clean and maintain hulls and propeller blades.
 - Consider upgrades to propellers and other hydrodynamic elements (boss cap fins, pre-swirl stators, etc.) to reduce URN from cavitation.
 - Participate in programs aimed at understanding URN for different vessel types, including assessing fleet noise signature.
 - Use dual frequency transducers for navigation by ocean carriers.
 - Obtain Green Marine certification by integrating best management practices for underwater noise reduction.
 - Encourage service vessel companies to minimize distances that service vessels travel to reduce overlap with SRKW foraging areas.
 - Limit commercial and recreational vessels' use of ultrasonic anti-fouling equipment and transducers until their impact is better known.
 - Set mitigation conditions that require monitoring and reporting of vessel movements if the number of transits exceeds the level originally described.
 - Encourage shipping companies to describe how they are integrating IMO guidelines for reducing underwater noise.
 - Incentivize recreational boater behavior and education, including Whales in Our Waters training, Be Whale Wise signage, whale warning flags, and whale reporting mechanisms.
 - Support Quiet Sound and Green Marine recognition efforts.
4. Washington Department of Fish and Wildlife. (2024). *2024 Southern Resident Killer Whale Vessel Adaptive Management Legislative Report*. Olympia, WA. <https://wdfw.wa.gov/sites/default/files/publications/02549/wdfw02549.pdf>

Includes request to fund WDFW's 2025-27 Enforcement decision package, which includes funding for a vessel for use in patrols for on-water enforcement.

Note: Focus is on commercial whale watching. The report notes that most violations are private recreational vessels. It does not include large commercial vessels.

5. Green Marine. (2021). *Long-term underwater noise management plan released by BC Ferries*.
<https://green-marine.org/stayinformed/news/long-term-underwater-noise-management-plan-released-by-bc-ferries/>

BC Ferries commits to reducing its URN by 50%. Key aspects of its plan include:

- Installing 3 hydrophones in different locations to enhance knowledge gathering about underwater noise and whale presence.
- Add Whale Trail signage to marine terminals.
- Update the Whales in Our Waters training. Train all crews.
- Report sightings to the BC Cetacean Sightings Network.

Existing Regulations and Guidelines for Puget Sound/Salish Sea

1. Be Whale Wise. Available at: <https://www.bewhalewise.org/>

Be Whale Wise is a collaboration between NOAA, the Department of Fisheries and Oceans Canada, Transport Canada, WA Department of Fish & Wildlife, U.S. Coast Guard, CETUS Research and Conservation/Straitwatch, and The Whale Museum/Soundwatch to educate boaters about regulations and guidelines for marine wildlife in Washington and Canadian waters.

Guidelines include:

- Educate yourself on behaviors of local whales and regulations.
 - Be alert and scan the water for marine life.
 - Go slow (<7 knots) when in the vicinity of marine life.
 - Place engine in neutral and allow all animals to pass if they approach the vessel or surface within the allowable distance.
 - Do not position your vessel in the path of wildlife.
 - Stay on the offshore side to lessen disturbance along the shoreline.
 - Limit wildlife viewing to 30 minutes or less to reduce cumulative impacts.
 - Never approach in distress; report it.
 - Fly your Whale Warning Flag if you see a whale.
2. Protection of southern resident orca whales—Unlawful activities—Penalty. RCW 77.15.740
 Available at: <https://app.leg.wa.gov/rcw/default.aspx?cite=77.15.740>

The Be Whale Wise website describes the mandatory measures as follows:

- Boaters must stay 1,000 yards* from Southern Resident killer whales.
- Boaters must go slow (<7 knots) within ½ mile of Southern Resident killer whales.
- Boaters must disengage engine(s) if Southern Resident killer whales appear within 400 yards.
- Boaters must stay 200 yards from other killer whales (Bigg's/Transient killer whales).
- Boaters must not park in the path within 400 yards of other killer whales (Bigg's/Transient killer whales)

NOTE: It can be difficult to determine different types of killer whales, especially at a distance when you're underway. When in doubt, err on the side of caution, treat them as endangered, and follow the appropriate regulations and guidelines.

See Appendix 1 for Washington Department of Fish and Wildlife's recommendations for interpreting RCW 77.15.740, RCW 77.65.615, and WAC 220-460 as a passenger-only ferry.

Defining Targets and Strategy

1. Green Marine. (2025). Performance Indicators: Underwater Noise.
<https://green-marine.org/certification/performance-indicators/underwater-noise/>

Green Marine is a voluntary environmental certification program that addresses issues specific to maritime transportation, including air, water and soil quality, biodiversity protection, and community relations. Certification is available for: ports and seaways, ship owners, shipyards, and terminals. To obtain Green Marine certification, participants must complete an annual self-evaluation across up to 15 performance indicators, specific to participant type. Performance is evaluated annually across 5 levels: Monitoring of regulations, best practices, integrated management and quantified impacts, new technologies and reduction targets, and excellence and leadership.

Performance indicators for ship owners include: Air emissions (greenhouse gases, NOx, SOx, and PM), aquatic invasive species, oily discharge, ship recycling, underwater noise and waste management. The levels of performance within the underwater noise indicator for ship owners are applicable to passenger-only ferry owners and operators:

- Level 1:
 - Monitor regulations.
- Level 2:
 - Conduct regular hull cleaning and propeller blade maintenance (keep a record for each vessel in the fleet).
 - Determine whether vessels transit through sensitive areas and communicate this to vessels.
 - Participate in voluntary traffic measures, such as a slowdown or lateral displacement, in specific zones as identified by port, governmental authority, or regional coalition.
- Level 3:

- Actively participate in collecting and providing whale sighting data through a logbook or recognized application (e.g. Whale Alert, Whale Report, Vigie marine). Sightings in logbooks should be shared with a recognized central database.
- Develop and adopt a Marine Mammal Management plan (MMMP) to reduce the potential adverse effects of vessels, especially within known sensitive marine areas.
- Level 4:
 - Incorporated applicable vessel quieting technologies during retrofits and new vessel construction. Refer to documents such as the IMO and SNAME MVEP Guidelines (AND)
 - Work with ports to estimate relative ship noise levels for at least one vessel in their fleet (OR)
 - Estimate relative noise levels of at least one vessel in their fleet by using a dedicated hydrophone and bioacoustician (OR)
 - Support/collaborate on scientific research on underwater noise allowing the estimation of relative ship noise levels for at least one vessel in their fleet.
- Level 5:
 - Conduct an in-depth analysis of vessel noise footprint on at least one ship in order to identify main noise sources. ANSI/ASA S12.64-2009 or ISO 17208-1:2016 underwater noise standard measurement methodology should be used where at all possible (AND)
 - Work with ports to estimate relative ship noise levels for 15% of vessels in their fleet, with a minimum of 3 vessels measured. (OR)
 - Estimate relative ship noise levels of 15% of vessels in their fleet, minimum 3 vessels, using a dedicated hydrophone and bioacoustician. (OR)
 - Support/collaborate on scientific research on underwater noise allowing the estimation of relative ship noise levels for 15% of vessels in their fleet with a minimum of 3 vessels measured.

Operational Measures

Dedicated Observers

1. Weinrich, M., Pekarcik, C., & Tackaberry, J. (2010). *The effectiveness of dedicated observers in reducing risks of marine mammal collisions with ferries: A test of the technique*. Marine Mammal Science, 26(2), 460–470.
<https://doi.org/10.1111/j.1748-7692.2009.00343>

Researchers placed a dedicated observer on a high-speed ferry (>25 knots) operating between Boston and Cape Cod, MA from 2002-2006. Humpback, fin, and North Atlantic right whales were spotted on nearly 40% of the over 2,000 transits during that period. In 56% of cases, the dedicated observer was the first to spot the whale, as opposed to another crew member. Further, observers were able to spot whales at distances greater than 400 m more often than the vessel's captain, but generally there was no difference in identifying type or size of the whale. No collisions

occurred on vessels with observers, while there was a high speed ferry without a dedicated observer that did have a non-fatal collision with a fin whale.

Avoiding Sharp Speed Accelerations

2. Lacrois, D., et al. (2022). *Avoiding sharp accelerations can mitigate the impacts of a Ferry's radiated noise on the St. Lawrence whales*. Sci Rep. 12(1).
<https://pmc.ncbi.nlm.nih.gov/articles/PMC9287373/>

This study analyzed how the source level of ferries differed at constant speed versus during acceleration/deceleration. It found that the ferries could be 10 dB noisier during periods of sharp speed changes compared to constant speed during operation. Mitigation recommendations resulting from this work include: avoiding sharp full-throttle acceleration or reverse-thrust deceleration and smoothly slowing down.

Quiet Design and Technology

1. Vard Marine Inc. (2019). *Ship underwater radiated noise*. Vard Marine Inc. Report 368-000-01. Prepared for the Innovation centre of transport Canada.
<https://voute.bape.gouv.qc.ca/dl/?id=00000165067>

This report presents the results of a review of means of mitigating and predicting the underwater radiated noise (URN) from ships. This noise can have significant environmental impacts, with damaging effects on marine animals of many types. The main outcome of the work undertaken is a matrix of URN mitigation measures. Measures are categorized in four main areas, covering propeller noise reduction; machinery noise reduction; flow noise reduction; and other, where the first three categories are not easily applied. The authors note that ferries can be diverse, and they separate their technology recommendations for ferries into those suited for slow/large vessels, slow/small vessels, and fast/small vessels, and further distinguish technologies best for retrofits and new builds.

Design strategies with the highest anticipated impact for fast/small ferries include:

- New builds
 - Propeller design (water jets, pump jets)
 - Machinery (Electric machinery, Gas/steam turbine)
 - Machinery treatments (Active cancellation)
 - Alternative fuels (Batteries or fuel cells)
 - Supplementary treatments (Air bubbler)
 - Hull treatments (Air lubrication)
- New builds and retrofits
 - Supplementary treatments (Application of anti-singing edge)
 - Machinery treatments (Resilient mounts, Vibration isolation, structural damping tiles, acoustic decoupling coating)

Caveats: The report is clear that every vessel build will likely see a different cost/benefit from the technologies listed. Only a few of the methods listed in the matrix have been explored in sufficient detail to precisely define their URN benefits in typical ship applications.

2. Vard Marine Inc. (2023). Ship Energy Efficiency and Underwater Radiated Noise. Report 545-000-01. Prepared for Transport Canada.
https://publications.gc.ca/collections/collection_tc/T22-266-2024-eng.pdf

This report provides a comprehensive review of technical and operational measures to increase energy efficiency and reduce greenhouse gas emissions and also mitigate underwater radiated noise from ships. Notably, the report includes a matrix of measures including:

- Effectiveness for energy efficiency, greenhouse gas mitigation, and underwater radiated noise reduction;
- Advantages and disadvantages;
- Applicability to different ship types (i.e. new builds vs. retrofits);
- Implementation costs;
- Technology Readiness Level.

Below is a selection of measures proven successful at reducing URN (TRL 9), that can be utilized during a retrofit for a ship like a passenger-only ferry (ship type 2). The matrix includes measures applicable for new builds and retrofits, but given the context of the passenger-only ferry fleet in Washington, only measures applicable to retrofits are included. Note that all of these measures have trade-offs, whether that be increased cost, decreased efficiency, increased maintenance, or increased weight.

- Propeller design
 - High skew propeller
 - Contracted loaded tip propellers
 - Contra-rotating propellers
 - Kappel propellers
 - Composite propellers
- Wake flow modification:
 - Propeller cap turbines
 - Costa propulsion bulb
 - Twisted rudder
 - CPP combinator optimizations
- Supplemental propeller treatments:
 - Improved manufacturing processes
 - Propeller blade maintenance
 - Anti-fouling coating
 - Application of an anti-singing edge
- Machinery treatments:
 - Resilient mounts
 - Floating floor (deck)
 - Raft foundation (double stage vibration isolation system)

- Acoustic enclosures
- Structural damping tiles
- Battery
- Hull treatments/appendages:
 - Underwater hull surface maintenance
 - Stern flat/wedge

3. Noise Control Engineering. (2025). *Current Technologies and Management Practices for Reducing Underwater Radiated Noise Produced by Vessels*.

This report identifies current technologies and management practices to reduce vessel-related underwater radiated noise, including technical feasibility and financial implications. Most of a vessel's URN comes from its propulsion system, followed by machinery noise. One of the most cost-effective strategies to reduce URN from propulsion systems is through optimizing wake adapted propeller designs. Additionally, designing the propeller and hull concurrently can help reduce URN.

Authors recommendations, in alignment with the IMO's Revised Guidelines for the Reduction of Underwater Radiated Noise include:

- A ship's baseline noise signature and causes of URN should be identified before developing and implementing an URN reduction strategy.
- URN assessments and subsequent design, technical and/or operational mitigation strategies should happen as early in the design process as possible.
- Modeling and analysis should continue through construction, delivery, and operation.

4. Peterson, G., White, D. (2025). *A BC Ferries Case Study: Lessons Learned in Setting Underwater Radiated Noise Targets*. MarineLink.

<https://www.marinelink.com/news/a-bc-ferries-case-study-lessons-learned-491247>

BC Ferries conducted vessel sound trial measurements using the hydrophone array in the Strait of Georgia. They found that a decrease in speed did not result in reduction of sound for its larger vessels. Subsequently, BC Ferries set a target of 50% reduction in underwater noise compared to the 2016 baseline, including specific frequencies ranges used by whales. They included this URN reduction target in the request for expressions of interest for shipbuilders. To help inform the design and build of new ferries, BC Ferries contracted with DNV to answer some key questions:

- Conducted a study to understand how URN could be reduced by modifying propellers. They found that it could be done, but would result in decreased engine efficiency and increased fuel consumption.
- Consulted with vendors to identify propulsion systems that are both quieter and fuel efficient.

Key lessons learned include:

- Obtain baseline noise data for vessels before setting reduction targets.
- Consider propeller design alongside hull design.
- Engage an expert to assess design impacts and trade-offs. Ensure they work with the shipbuilder.
- Anticipate balancing energy efficiency and noise reduction goals.

5. Port of Vancouver. (2025). *EcoAction Program*.

<https://www.portvancouver.com/sites/default/files/2024-11/PV-EcoActionInfographic.pdf>

The Port of Vancouver regularly assesses vessel and engine technologies that vessel owners and operators use to meet their EcoAction Program award levels. For underwater noise, this includes:

- Nakashima GPX Propeller
- Nakashima Neighbor Duct
- Nakashima Composite Stator
- Nakashima Ultimate Rudder
- Nakashima ECO-Cap
- Becker Mewis Duct
- Kamome Propeller Gate Rudder
- MMG Energy Savings Cap (MMG-escap(R))
- Propeller Boss Caps Fin (PBCF)
- Schneekluth duct
- Warsila EnergoProFin

6. Rudd, A.B., Richlen, M.F., Stimpert, A.K., Au, W.W.L. (2014). *Underwater Sound Measurements of a High Speed Jet-Propelled Marine Craft: Implications for Large Whales*. Pacific Science, Vol.69, No. 2.

https://www.researchgate.net/publication/279853060_Underwater_Sound_Measurements_of_a_High-Speed_Jet-Propelled_Marine_Craft_Implications_for_Large_Whales

Underwater radiated noise was measured from an aluminum-hull catamaran powered by two propulsion jets (i.e. water jets). Especially at higher speeds, the vessel was quieter than reported SPL of other vessels. It was unclear whether the lower noise level was a result of water jet propulsion, as opposed to hull shape, ship loading, and vessel size.

Whale Detection/Alert Technologies

1. AIP Publishing. (2021, May 21). *Using context to train time-domain echolocation click detectors*. The Journal of the Acoustical Society of America.

<https://pubs.aip.org/asa/jasa/article/149/5/3301/607499/Using-context-to-train-time-domain-echolocation>

This technical research paper explores advanced methods for improving the automated

detection of marine mammal echolocation clicks within passive acoustic monitoring (PAM) data. The study focuses on using the surrounding acoustic context to better train detector algorithms, which helps reduce false positives and enhance overall accuracy. This source is highly relevant for understanding the machine learning and signal-processing challenges that must be overcome to transform raw acoustic data into reliable alerts for maritime operations.

2. IFAW. (n.d.-a). *Saving NARW: High-tech solutions to prevent vessel strikes*. Retrieved June 6, 2025
<https://www.ifaw.org/international/journal/high-tech-solutions-to-prevent-vessel-strikes-north-atlantic-right-whales>

This article provides a summary of various technologies aimed at protecting the North Atlantic Right Whale (NARW) from ship strikes. It highlights several key tools, including the Whale Alert app, the deployment of passive acoustic monitoring buoys, and the use of the Automatic Identification System (AIS) to transmit real-time warnings directly to vessels. It effectively makes the case for a multi-pronged technological approach to conservation.

3. Whale Safe. (n.d.). *Methodology*. Retrieved June 7, 2025, from
<https://whalesafe.com/methodology/>

This source details the three-part methodology of the Whale Safe system, designed to prevent whale-ship collisions. It explains how the system integrates data from an acoustic monitoring buoy, a near real-time whale habitat predictive model, and visual sightings from trained observers and citizen scientists. The page describes how these data streams are combined to generate a "Whale Safety Score" for ships, grading their cooperation with voluntary speed reduction zones. This is a primary reference for a state-of-the-art, integrated system that translates complex detection data into an actionable risk assessment for the maritime industry.

4. Zitterbart, D. P., Smith, H. R., Flau, M., et al. (2020). Scaling the laws of thermal imaging-based whale detection. *Journal of Atmospheric and Oceanic Technology*, 37(5), 807–824. <https://journals.ametsoc.org/view/journals/atot/37/5/jtech-d-19-0054.1.pdf>

This academic paper provides a scientific analysis of the effectiveness of thermal imaging for whale detection. The research evaluates the technology's performance across different oceanic environments, quantifies its detection range, and analyzes the significant impact of environmental factors like wind and fog. It is a foundational scientific source that establishes the performance characteristics of thermal imaging and demonstrates that, under certain conditions, it can outperform human observers.

Appendix A

General interpretation of how RCW 77.15.740, RCW 77.65.615, and WAC 220-460 apply to Passenger-Only Ferries (POF)

Authored by: Julie Watson, Washington Department of Fish and Wildlife, 9/22/25

Commercial whale watching requirements in RCW 77.15.740 and in WAC 220-460 (based on licensing requirements in RCW 77.65.615/620) apply to anyone who **takes** or **offers to take** someone aboard a vessel to view marine mammals in their natural habitat for a fee. So, if an entity like a POF **advertises** marine mammal viewing or **engages** in the activity of marine mammal viewing (e.g. purposefully stopping or diverting course to give passengers a marine mammal viewing experience), that entity needs the commercial whale watching license and needs to follow the rules for commercial whale watching vessels, including but not limited to (see RCW/WAC for full details):

- Having valid CWW licenses for the operator (CWW operator license), business, and vessel (CWW business license)
- Staying 1,000 yards from SRKW
- Reporting any sighting or encounter with SRKW to the Whale Report app
- Using AIS (class A or B) at all times while operating

An entity offering POF service that **does not advertise** marine mammal viewing in their ferry service website/materials **and does not change behavior** to pursue or capitalize on marine mammal viewing opportunities would not need the CWWL, and the CWW rules in RCW 77.15.740 and WAC 220-460 would not apply. The general rules for vessels operating around SRKW in RCW 77.15.740 (e.g. the 1,000 yard setback) would apply; however, in their capacity as ferries, they would likely qualify for the exemption in (2)(b) because they would be operating in the realm of Vessel Traffic Service (VTS).

Best practices for POF that also conduct CWW:

- Follow the CWW rules even when operating as a POF (e.g., have the correct licenses, use AIS, report SRKW sightings, stay 1,000 yards from SRKW).
- If an entity wants to more fully separate their POF from their CWW:
 - o Ensure there is no suggestion or advertising of whale watching as part of the POF webpage and materials.
 - o Communicate with WDFW licensing staff (cwwl@dfw.wa.gov) and Enforcement staff to let them know what vessels will be used for POF, and the anticipated POF schedule if available.
 - o While operating as a POF, do not stop or maneuver to facilitate marine mammal viewing beyond what passengers inadvertently see whilst transiting the specified route.
 - o Do follow all other POF best practices, including safe operations near marine mammals.

Relevant requirements for POFs

- A. Any entity that offers **ferry service and does not advertise or engage in** marine mammal viewing
 - o RCW 77.15.740 applies, but most POF activity is likely exempt
 - e.g. operating in the realm of VTS—exemption (2)(b)
 - e.g. when actively taking safety measures—exemption (2)(e)
 - o No CWWL (Commercial Whale Watching License) requirements apply
 - RCW 77.65.615 does not apply
 - WAC 220-460 does not apply
- B. Any business or organization that **advertises and/or engages in marine mammal viewing as part of ferry service**
 - o RCW 77.15.740 applies
 - o RCW 77.65.615 applies- Need CWWL (CWW business including vessels, + CWW operators)
 - Note: The license and application fees may be waived for organizations whose relevant commercial whale watching activities are solely for bona fide nonprofit educational purposes.
 - o WAC 220-460 and RCW 77.15.740(7)-(8) apply. Must follow all CWW rules, including (but not limited to) annual training, use of AIS when operating, staying out of the no-go zone on the West side of San Juan Island, and reporting SRKW sightings to the Whale Report app.

Relevant requirements for CWW businesses who may seek contracts with jurisdictions to conduct POF services

- C. For any CWW businesses business or organization that **advertises and/or engages in marine mammal viewing as part of ferry service, see B above**
- D. If CWW vessels/operators are involved in **ferry-only services**, i.e. **not advertising marine mammal viewing** as part of POF service and **not engaging in whale watching activity** while making ferry transits
 - o RCW 77.15.740 applies, but most POF activity is likely exempt
 - o RCW 77.65.615 already applies to the business and operator because of the separate CWW activity, so the business, operators, and vessels involved would already be subject to the CWWL
 - Note: Potential benefit-- Any licensed CWW operators will have completed annual training and be well-qualified to identify marine mammals and follow applicable laws.
 - o WAC 220-460 and RCW 77.15.740(7)-(8) do not apply to the POF operations, but are recommended as a best practice (e.g. reporting SRKW sightings to Whale Report, using AIS while en route) for ferry-only transits

- E. If a CWW business has a **separate vessel and separate operators** never used for CWW, only used for **ferry-only services**, i.e. **not advertising marine mammal viewing** as part of service and **not engaging in whale watching activity** while making ferry transits
- o RCW 77.15.740 applies, but most POF activity is likely exempt
 - o RCW 77.65.615 already applies to the business because of the separate CWW activity, but
 - The vessel/operator would not need to be listed in the CWW Business License
 - The operator would not need an Operator License
 - o WAC 220-460 and RCW 77.15.740(7)-(8) do not apply to the POF operations, but are recommended as a best practice