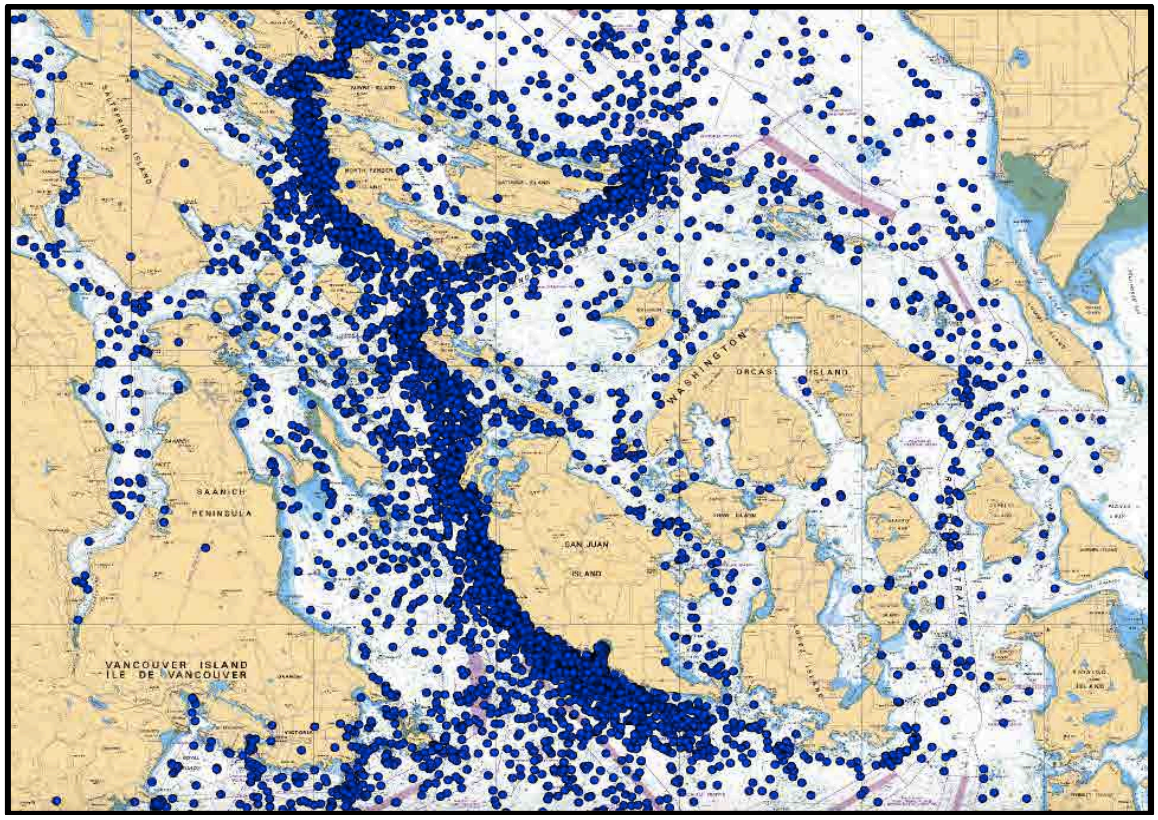
Annex 3.F.4

Ship Noise Mitigation Risk Assessment, Greenwood Maritime Solutions Ltd

Transports Canada Transport Canada

Ship Noise Mitigation Risk Assessment



Prepared for Transport Canada

This report reports on a high-level Risk Assessment of various measures to reduce ship-generated noise in the Salish Sea to mitigate impacts on Southern Resident Killer Whale Populations.

Prepared by Nigel Greenwood, MM, FRIN, FNI
Greenwood Maritime Solutions Ltd.

28 March 2018

Greenwood Maritime Solutions Ltd
4022 Rainbow Hill Lane, Victoria, BC V8X-0A6
nsg@greenwoodmaritime.com
M 250-507-8445

GREENWOOD MARITIME

Ship Noise Mitigation Risk Assessment

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Presented to:

Michelle Sanders
Environmental Affairs - Policy (ACS)
330 Sparks St., 26th Floor (ACS)
Place de Ville, Tower C
Ottawa, ON, K1A 0N5

Prepared by:

Nigel S. Greenwood, FRIN, FNI

Greenwood Maritime Solutions Ltd.
4022 Rainbow Hill Lane,
Victoria, BC V8X 0A6
M 250-507-8445
nsg@greenwoodmaritime.com
www.greenwoodmaritime.com

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Background

Many recent studies have highlighted the declining populations of Orcas in the Salish Sea. Both the Northeast Pacific Transient Killer Whales (NPTKW) and the Southern Resident Killer Whales (SRKW) are at risk, being defined as Threatened or Endangered in accordance with Canada Species at Risk Act.[1] One of the key factors thought to be impacting the foraging and reproductive habits of these marine mammals is the increasing volume, size and speed of shipping in the Salish Sea. Apart from the danger of physical interaction in the form of ship-whale strikes, the propagation of broadband noise from ships' engines, propellers and hull flow noise is believed to be disorienting and disrupting in areas of seasonal or habitual foraging. Accordingly, several initiatives have been launched in in recent years to identify ways in which ship-noise may be minimized.

One of the key initiatives to reduce ship-generated noise in the Salish Sea is a project of the Vancouver-Fraser Port Authority (VFPA) aimed at understanding and managing the impacts of shipping on at-risk whales in southern BC. The Enhancing Cetacean Habitat and Observation (ECHO) Program was stood up in 2014 and from 2016 has included input from a Vessel Operators Committee.[2] ECHO has undertaken a number of initiatives to examine the prospects of mitigating ship-noise. These have included studies to try to quantify the beneficial effects of ship-quieting through construction incentives, speed reductions and lateral displacement of traffic. JASCO Applied Sciences Ltd conducted a study in 2017 to identify regional noise contributors and characterize the overall underwater sound environment from traffic studies and related hydrophone records. This study concluded that, while small vessel traffic could not be quantified reliably, the major source of noise in Haro Strait (a key area of concern) was largely attributable to deep-sea shipping traffic.[3] Accordingly, VFPA conducted a voluntary vessel slow-down trial August-October 2017 to determine the level of noise reduction resulting from a transit speed of 11 knots (through the water).[4]

The Department of Fisheries and Oceans (DFO) also carried out an evaluation of the potential effectiveness of a number of measures to reduce ship noise.[5] This study was

[1] http://www.dfo-mpo.gc.ca/species-especes/profiles-profils/killerWhalesouth-PAC-NE-epaulardsud-eng.html, accessed 9 March 2018; http://laws-lois.justice.gc.ca/eng/acts/s-15.3/, accessed 9 March 2018

[2] VFPA, ECHO Program Annual Report 2016, https://www.portvancouver.com/wp-content/uploads/2017/01/ECHO-Program-Annual-Report-2016-FINAL.pdf, accessed 9 March 2018

[3] JASCO, Regional Ocean Noise Contributors Analysis, 2017, https://www.portvancouver.com/wp-content/uploads/2017/01/Regional-Ocean-Noise-Contributors.pdf, accessed 9 March 2017.

[4] VFPA, Vessel Slowdown Trial 2017, https://www.portvancouver.com/environment/water-land-wildlife/marine-mammals/echo-program/vessel-slowdown-trial-in-haro-strait/, accessed 9 March 2018

[5] DFO, Evaluation of Scientific Evidence to Inform the Probability of Effectiveness of Mitigation

completed through the Canadian Science Advisory Secretariat (CSAS) to provide science advice on the probability of effectiveness of both source-based and operations-based mitigation measures to reduce shipping noise. Among the possible measures proposed were:

- Vessel speed reductions
- Relocation of shipping lanes (lateral separation of source from SRKW)
- Changes in timing of traffic
- Changes in shipping practices
- Changes in ship design and retrofits to existing ships
- Redirection of traffic
- Changes in maintenance procedures (i.e.: hull cleaning)
- Operational responses to observed presence of SRKW (i.e.: slow-down and course alteration)
- Grouping vessels (i.e.: “convoy”)
- Creating periods of quiescence (i.e.: alternating active/inactive shipping periods)

Subsequent to this DFO CSAS report, a workshop of the VFPA ECHO Program in October 2017 attempted to rank these options in terms of feasibility. Among the findings of this workshop was the need for greater clarity on the exact nature and proposed (practical) implementation of the measures and a more rigorous approach to analysis of the (navigational) safety risks inherent in the options.[6] Accordingly, Transport Canada asked for this Risk Assessment of the Ship Noise Mitigation Measures.

1.2 Task

The explicit task of this project is:

To assess and quantify the navigation safety risks, using the PRMM methodology, associated with introducing or implementing potential mitigation measures to address underwater vessel noise in the Salish Sea.[7]

1.3 Scope of Investigation

The project was initiated through discussions and Statement of Work development from August to December 2017, with contract award permitting commencement on 24 January 2018. With a remit to be complete before 31 March 2018, the scope of the project was very tightly focused on practical, navigational risks and not on economic, commercial or cultural impacts. The Risk Assessment acknowledged at the outset that a full range of impacts will have to be considered in due course, involving a wider representation of interested parties, and this was noted by Transport Canada as part of the following plan of action. For this project, however, the aim was to use the PRMM

Measure in Reducing Shipping-Related Noise Levels Received by Southern Resident Killer Whales, Science Advisory Report 2017/041, http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2017/2017_041-eng.html, accessed 9 March 2018

[6] ECHO Program Workshop, letter to DG Environmental Policy, Science Branch, Transport Canada, 19 October 2017

[7] Transport Canada T8080-170444 SOW – PRMM Project, by email 22 Dec 2017

process to examine purely navigational risk factors to identify which of the measures, if any, might be implemented with sufficiently low risk to warrant further examination and further engagement with various groups, communities, experts and stakeholders.

1.4 Measures to be Examined

The Statement of Work defined the Measures to be examined in four broad categories. Following discussion at the Orientation Session and further specification by TC, the list was resolved to the following discrete Measures:

1. Lateral Displacement:
    a. Protected area E in Haro Str: This takes into account traffic displacement as a consequence of a Whale Protection Zone (WPZ) as proposed by the Orca Relief Citizens' Alliance on San Juan Island;[8]
    b. SC route west of Haro Str lane: This proposes a small-craft route North-South on the west side of Haro Strait to displace small vessels from the habitual SRKW foraging area close to San Juan Island;
    c. SOA - Haro Str One-way: This proposes a Special Operating Area extending from Turn Point south to Beaumont Shoal, with rules precluding meeting traffic in Haro Strait, with the result of allowing greater lateral displacement of shipping from the San Juan Island shore;
    d. SJDF - Shift outbound N of SB: This proposes moving the outbound traffic at the mouth of the Strait of Juan de Fuca to go north of Swiftsure Bank, thus avoiding small craft and fishing vessels on the Bank;
    e. SJDF - Shift all lanes further S of SB: This proposes to move the whole TSS at the entrance to the SJDF south to provide greater separation from the small craft on Swiftsure Bank;[9]
    f. Shift SJDF TSS off Sooke to south: This proposes a shift of the TSS (or at least the outbound lane) further to the south between Race Rocks and Sooke to provide greater lateral separation from SRKW in this area.

2. Quiescence:
    a. Quiet Periods: This proposes in Haro Strait to alternate active shipping periods with quiet periods, say on 4-hour blocks, to provide noise respite for SRKW. This would require timing of arrivals and departures to meet these windows, or otherwise to hold vessels on Constance Bank or Boundary Pass pending the transit periods;
    b. Schedule transits: This proposes to group vessels in Haro Strait ("convoy") so as to have fewer periods of noise. This would require protocols (schedules, maximum numbers, minimal distance separations, common speed) to effect this, as well as limiting waits pending "critical mass";
    c. Manage transits: This proposes managing vessel transits in Haro Strait

[8] Orca Relief Citizens' Alliance, Petition to Establish a Whale Protection Zone, November 2016, http://www.orcarelief.org/regulatory-request/, accessed 9 March 2018

[9] It was noted that this is a regressive step towards where the TSS was prior to 2006. See the Federal Register on TSS changes, https://www.federalregister.gov/documents/2010/11/19/2010-29165/traffic-separation-schemes-in-the-strait-of-juan-de-fuca-and-its-approaches-in-puget-sound-and-its, accessed 9 Mar 18

around SRKW presence. This would require a verifiable alerting scheme for SRKW presence and holding arrangements at Constance Bank inbound or in port/Boundary Pass for outbound ships. Some provision for maximal wait times would have to be established;

d. Tidal transits: This proposes to route ships with the tidal currents. Some provisions would have to be determined for the periodic recurrence of diurnal tides (only one in/out transit period per day) and for slow traffic unable to complete the transit in one half tidal cycle;

3. Redirection
   a. Redirection through Rosario: This proposes to route all inbound traffic through Rosario Strait. This would require such traffic be streamed through Port Angeles for Puget Sound Pilots and BC Pilots be embarked before Roberts Bank;
   b. Conditional redirection to Rosario: This proposes a rerouting through Rosario Strait conditional on the presence of SRKW in Haro Strait. This would require some verifiable alerting scheme for SRKW presence and more complex arrangements of pilot embarkation;
   c. One-way Rosario-Haro (I/O): This proposes that traffic be routed counter-clockwise through Rosario-Haro Straits. This is similar to 3a above but would require outbound traffic from Anacortes and lower Rosario Strait to travel the long-way-round to exit via Haro Strait.

4. Speed Reduction
   a. Fixed SP Limit in Haro: This proposes a fixed maximal speed limit for all traffic in Haro Strait, in the order of 10-12 knots. Different restraints might have to be devised for smaller vessels;
   b. Circumstantial SP Limit in Haro (SRKW): This proposes to limit speed depending on the presence of SRKW in Haro Strait. This would require some verifiable alerting scheme for SRKW presence, or otherwise be dependent on vessel operator lookout and response;
   c. Conditional SP Limit in Haro (Vessels): This proposes some speed limit conditional on each vessel's acoustic profile, which would go in hand with incentives for ship quieting in construction;
   d. Circumstantial SP Limit in SJDF: This proposes a speed limitation dependent on the sighting of SRKW in SJDF.

1.5 Constraints/Restraints

To clarify the points made above and to limit discussion to relevant factors, the following Constraints and Restraints were developed in conjunction with TC and introduced to the participants at the Orientation Session 7 February 2018:

Constraints: This project ***is*** about:

- Hypothesizing in greater (operational) detail the proposed Measures
- Outlining the issues involved in implementing these Measures
- Determining the (operational) risk factors associated with the proposed Measures
- Determining if mitigations of such risk factors is required or possible (without eliminating benefits of the proposed Measures)

- Arriving at a qualitative Risk Assessment of implementing the proposed Measures

Restraints: This project ***is not*** about:

- Efficacy of the proposed Measures (science programmes are addressing this)
- Economic impact of potential Measures (subsequent TC initiatives will cover this)
- Collaborative mechanisms for addressing vessel traffic management (a separate TC project is addressing this)
- Consultation with interested coastal communities (future outreach and engagement will address this)

Great concern was expressed by some participants over the exclusion of coastal communities and diverse marine interest groups from the discussion, especially First Nations and Tribes on both sides of the border. The facilitators and TC project directors affirmed that this was not to discount the interests or perspective of potentially impacted communities but to focus the effort at this stage on the perspectives of those with deep nautical knowledge of the navigational challenges of major shipping in the study area. Furthermore, the output of the project is only to identify those potentially acceptable for further study and refinement, not to make a positive recommendation for implementation of any particular measure.

1.6 Qualifications of the Contractors

The lead author, RAdm Nigel Greenwood is a 37-year surface warfare officer of the Royal Canadian Navy (RCN), whose last jobs included responsibility for maritime defence of western Canada and search and rescue (SAR) for BC and the Yukon. He was a navigation specialist who conducted his naval pilotage training on the west coast and commanded a frigate in local waters for two years.

Captain William Devereaux is a 30-year veteran of the US Coast Guard, in which he held command of a cutter based in Alaska and also led the Puget Sound Vessel Traffic Services for three years. In this latter domain he has been intimately involved in the development of Standards of Care in traffic management and the negotiation of Traffic Separation Scheme changes.

Both RAdm Greenwood and Capt. Devereaux are qualified in Transport Canada's Pilotage Risk Management Methodology. They have recently collaborated in such projects as the Pacific Pilotage Authority's Pilotage Waivers Review.

2. METHODOLOGY

2.1 PRMM

This project was conducted in accordance with Transport Canada's Pilotage Risk Management Methodology.[10] This is a formulated approach to a workshop discussion of operational scenarios in a marine navigation setting. The process involves:

- Clarification of the purpose of the Risk Assessment (the "RA Question")
- Identification of risk scenarios
- Determination of contributory factors
- Determination of Probability and Consequence of various outcomes
- Calculation of Risk from Probability and Consequence
- Determination of possible risk mitigations
- Calculation of Residual Risk from mitigated Probability and Consequence
- Determination if the Residual Risk is acceptable

TP 13741E provides a standardized guidance table to Probability and Consequence levels across the domains of Human, Property, Vessels, Environmental and Reputation impacts. Each of these is defined in five broad levels, and RA team members are asked to use personal knowledge and professional judgment to determine what is the appropriate level (i.e. 1 to 5) of Probability and Consequence for each adverse outcome. Risk is calculated accordingly as Probability x Consequence to give a Risk figure out of 25. This is to be understood in this process as a relative, subjective assessment of risk for which the RA Team must determine if this is acceptable or not.

2.2 Orientation

An orientation session was conducted on 7 February 2018, two weeks after commencement of the project. Representation was requested from Government agencies, industry, and particularly pilotage authorities on both sides of the border. The intent of this session was to define the project, explain the process of the PRMM, and otherwise gather input to help situate the following work.

The table at Annex A indicates the participants in the RA. While every effort was made to ensure the participation at both the Orientation Session and the Risk Assessment Workshop, this was not possible for all attendees. The orientation session laid out the process and answered a number of questions, largely around issues defined by the Constraints and Restraints above.

2.3 Risk Assessment and Interviews

Following the Orientation, participants were sent a dropbox link on Monday 12 February, and subsequent emailings of the related files, giving access to the Orientation Brief, a

[10] TP 13741E (05/2010), PRMM handbook, http://publications.gc.ca/collections/collection_2010/tc/T29-70-2010-eng.pdf, accessed 9 March 2018

template Risk Assessment Table, and Instructions for Completion of the Risk Assessment. They were requested to complete the RA and return the table by 19 February in order to allow individual follow-up before the 1 March Risk Assessment Workshop.

The RA Template was returned by 13 participants, including the two facilitators and the TC Project Director. Six participants in the Orientation session declined to fill in the table on the basis of lack of specific nautical familiarity with the subject matter and geographical area. Of those who completed the RA, all were experienced mariners of different grades of command qualification, from Naval Command Qualification to Master Mariner to Senior Pilot. The average sea-time among this group was over 23 years, and familiarity with the Salish Sea was variously qualified but averaged “4” on a five point scale. The average time to complete the RA was 5.2 hours.

Follow-up interviews were conducted with 10 of the 13 respondents (i.e. excluding the consultants, all but one of the respondents) between 16 February and 27 February. The purpose of this interview was to collect the experiential data and to confirm or clarify responses. In some cases, the responses were inconsistent between Measures or between initial assessments and mitigated Probability/Consequence. Respondents were given the opportunity to explain their choices/assessments and to amend these if errors had been made. These interviews averaged between 30 and 60 minutes apiece.

Following the interviews, the results were combined to give a starting point for discussion at the RA Workshop on the 1st March. It should be noted that the figures were averaged to give a sense of the median position and the spread of opinion between the participants. What is presented as an average figure in the results is not a formal, statistical average of all participants for several reasons. First, it is firmly biased in the direction of the nautical practitioners’ views, as the other RA participants declined to venture an opinion on the specific risks. Secondly, the BCCP and PPA representatives elected to do the RA together, so their input was counted as one submission rather than four identical but independent submissions. And lastly, the full data sample was still very small and not appropriate for rigorous analysis. Nonetheless, the results very clearly indicated the direction of collective assessment, even if the variance between responses was very large in some instances.

2.4 Risk Assessment Workshop

The RA Workshop was conducted from 1000-1415 on 1 March at the offices of the Chamber of Shipping of BC. Fifteen participants attended the RA Workshop in person, while 3 others called-in. Of these 18, 14 (including the facilitators) had also attended the Orientation Session. Those present in person or attending by phone represented 11 of the RA responses.

The RA Workshop commenced with a Power-point Brief to refresh the purpose of the project and to share the results of the individual assessments. This brief is attached in Pdf form as Annex B, with amendments as suggested at the workshop.

3. DISCUSSION

Several items of information were presented at the workshop to answer questions raised in the Orientation Session and through individual interviews. These are covered below.

3.1 Presence of Killer Whales in the Salish Sea

A recurrent question was about the presence, location and prevalence of whales in the Salish Sea. It was related by several participants that whereas much concern had been raised about the SRKW in Haro Strait, the period of the VFPA's ECHO Program slow-down trial was notably light in SRKW presence. Doubt was expressed as to the driving imperative for mitigating measures.

Between the two sessions, the BC Cetaceans Sighting Network was approached for locating information on Killer Whales in the Salish Sea. This sighting data was provided with the caveat that this is raw sighting data and is not corrected for effort.[11] A plot of this data is included within Annex B. The data corrected for effort as in Figure 1 confirms that Haro Strait and Sooke are hot-spots of whale presence, although this plot does not as distinctly show that the presence is closely clustered to the San Juan Island west shore.

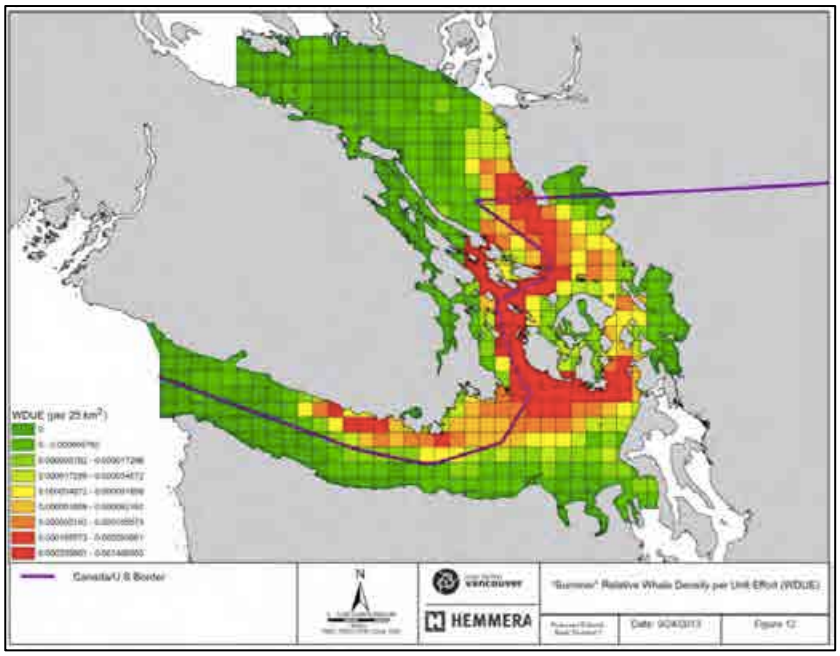

Figure 1. Summer Whale Density per Unit Effort (WDUE) in the Salish Sea[12]

The facilitators noted that the project is not tasked to verify the case for ship-noise mitigating measures, only to assess if they are acceptable from the standpoint of

[11] BC Cetaceans Sighting Network, http://wildwhales.org, data provided by email from Jessica Torode to Nigel Greenwood, 27 February 2018

[12] Courtesy of VFPA ECHO Program; SMRU Canada Ltd, Roberts Bank Terminal 2 Technical Data Report, Marine Mammal Habitat Use Studies, prepared for Port Metro Vancouver December 2014

navigational safety.

3.2 Traffic Patterns and Volume in the Salish Sea

The RA Team debated the volume and pattern of marine traffic in the Salish Sea. Of particular concern was the presence and tracks of pleasure craft, particularly in the summer months. A number of AIS heat-map plots were provided by the USCG, of which Figure 2 below is representative of the busiest months. The red parts of the plot indicate the areas of more frequent ferry traffic in the summer. These tracks are also augmented by heavier density of pleasure-craft, although many of these vessels will not be carrying or transmitting on AIS and so are not captured in this plot. Nonetheless, some of these tracks do include non-commercial traffic; those tracks from Sidney up through Dock Is, and the traffic along the west side of San Juan and Pender Islands are illustrative of this component of marine activity. Other than this, the separated lanes and nodes of the Traffic Separation Scheme are well-defined by this plot.

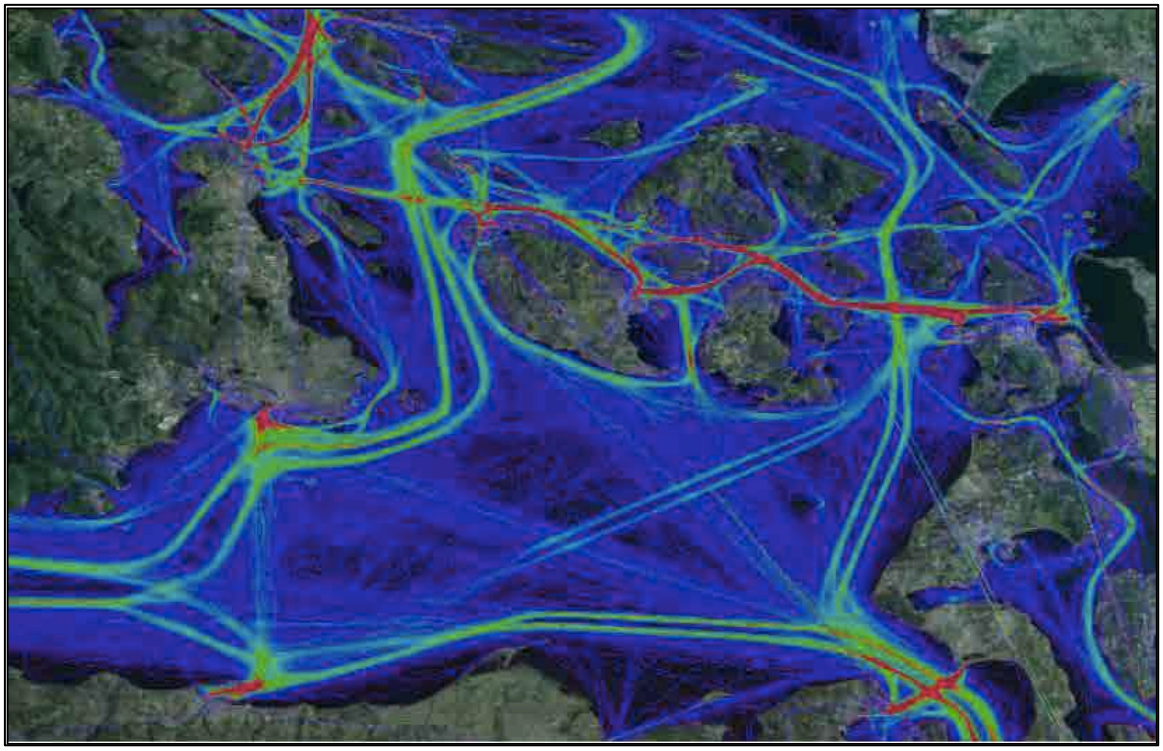

Figure 2. Traffic Patterns in the Salish Sea in August (USCG)[13]

There is no good estimate of pleasure craft density in Haro Strait. The JASCO report for VFPA on noise contributors in the Salish Sea[14] notes that the true volume of recreational vessels is greatly underestimated by the record of AIS tracks from such vessels, but that in two previous studies to physically confirm numbers in order to scale-up AIS densities

[13] Personal communication from Capt. L. Hail, USCG
[14] JASCO, Regional Ocean Noise Contributors Analysis, 2017, https://www.portvancouver.com/wp-content/uploads/2017/01/Regional-Ocean-Noise-Contributors.pdf, accessed 9 March 2017.

neither were satisfactory in establishing the overall size of the recreational fleet. The issue is of concern especially in Haro Strait, where one of the proposed measures (an exclusion zone along the San Juan Island shore) could force small traffic into closer proximity with deep-sea traffic. The facilitator's estimate of 25-30 recreational vessels at a time in Haro Strait was considered by more experienced members of the RA Team to be very low for good weather periods.

3.3 Marine Accident/Incident Statistics in the Salish Sea

Two lines of investigation were pursued to try to baseline marine incidents in the area under discussion. A database of all Marine Occurrences for the Pacific Region, 1997-2016, previously obtained from the Transportation Safety Board of Canada[15] was examined for incidents in the study area. A similar database of occurrences was obtained from the USCG covering the years 1992-2017.[16] These two data sets were not directly comparable as different accident/incident/occurrence definitions are used. However they do permit some generalizations of navigation safety experience in Haro and Rosario Straits.

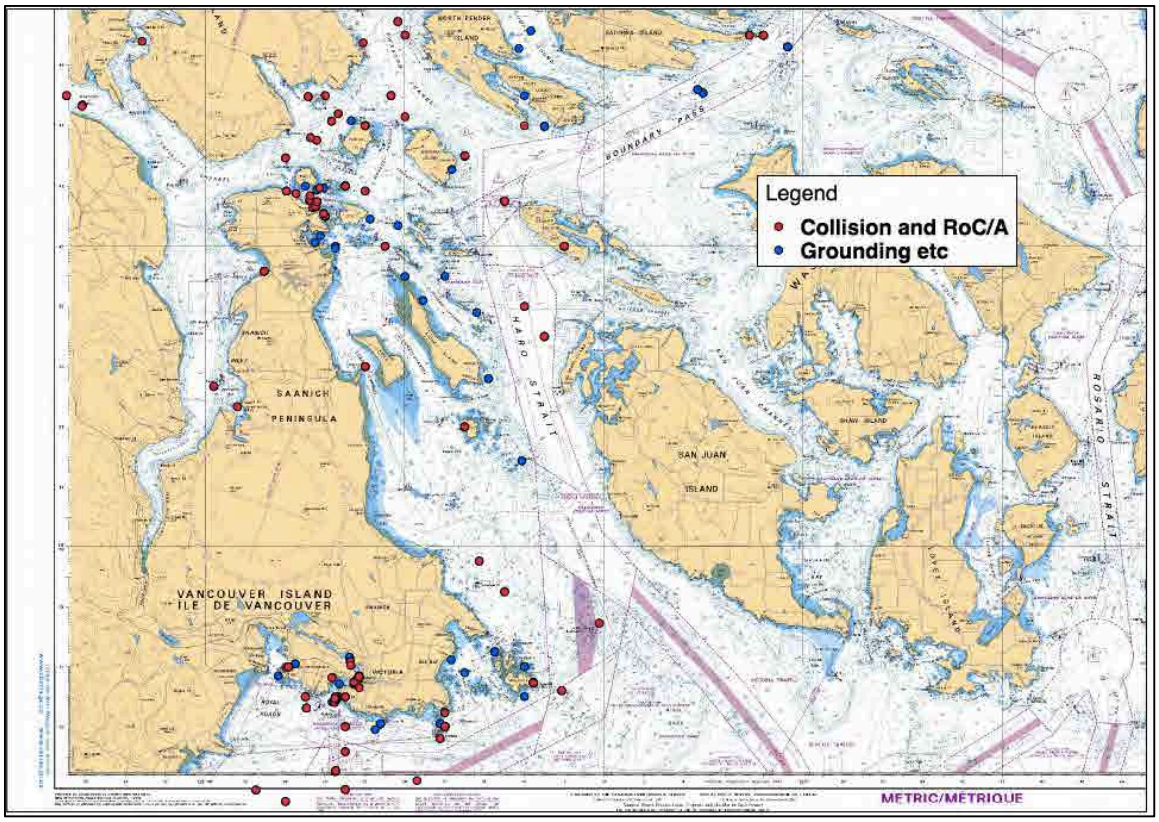

Figure 3. Plot of Collisions and Groundings (including Risks of Collisions, Grounding and Allisions) in Haro Strait, all vessels, 1997-2016

[15] TSB, Marine Occurrences 1997-2016, by personal communication from Olga Gordynska, 14 March 2017, for the Pacific Pilotage Authority Waivers Risk Assessment.
[16] Vessels Casualties list, USCG, personal communication from Capt Laird Hail via William Devereaux, 27 February 2018.

Both the Canadian and US datasets list a full range of occurrences from serious accidents to near-misses and temporary ship-board material or personnel casualties. Figure 3 shows the Canadian data in the Haro Strait – Boundary Pass area, limited to Collisions, Groundings and Strikings (Allisions) as well as reported risks of those outcomes. When filtered down to actual accidents in the principal study area (bounded by latitudes 48.33 to 48.83 degrees North and longitudes 117.05 to 123.33 degrees West), each list yields only 31-43 collisions, groundings and strikings over a 20-year period. This includes only 3 deep-sea ships on each side, with the majority of accidents being attributable to fishing vessels (15 and 8), tugs and tows (3 and 4), and passenger vessels (3 and 17). Examination of the Canadian accidents (not incidents, which cover near-misses) in Haro Strait itself reveals that none of these were deep-sea vessels in the last 20 years.

Canadian Marine Accidents in the Haro-Rosario Area 1997-2016																
Accident/ Year	1997	1998	1999	2000	2001	2002	2003	2004	2006	2007	2008	2009	2010	2014	2016	Grand Total
BOTTOM CONTACT				1		1									2	4
COLLISION														1		1
GROUNDING	1	1	2		2	1	1	2	1	1	3	2	1		2	20
STRIKING	3					1						1			1	6
Grand Total	4	1	2	1	2	3	1	2	1	1	3	3	1	1	5	31

Table 1. Canadian Accidents in the study area

US Marine Accidents in the Haro-Rosario Area 1997-2016																		
Accident/ Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Grand Total
COLLISION				1		1								1		1		4
GROUNDING	1	1	1	1	2		4		4	2	1	2	1	4	1		2	27
ALLISION		1	1		1	3		1					2	1		1	1	12
Grand Total	1	2	2	2	3	4	4	1	4	2	1	2	3	6	1	2	3	43

Table 2. US Accidents in the study area

This information is important for base-lining the Risk Assessment process. The number of accidents over the amount of time gives us data for Probability of accidents happening in the status quo scenario. The results of these accidents over time, gives us an idea of the consequences in the status quo scenario. Based upon the table in Annex B, page 29, this would result in a Probability of 4 and a Consequence of 2 for a Risk of 8. If every tenth accident resulted in a death, this would be 2 x 4 for a Risk Figure of 8 also. In this example, a Risk Figure of 8 fairly represents the combined risk of these two different outcomes.

4. RISK ASSESSMENT

4.1 Key Concerns

Throughout the RA, two principal concerns recurred. The first of these was the prospect of small craft being forced into interaction with deep-sea vessels. While the prospect of collisions and groundings by large ships was considered serious, it was deemed likely fatal if a small craft should be in collision with a deep-sea ship. The unpredictability of small craft movements and the inability of large vessels to make radical evasive manoeuvres makes for a possibly more serious outcome than possible interaction between major ships under pilotage and also participating in VTS.

The second concern was the likelihood of some scenarios creating circumstances where vessels not under pilotage would be forced to loiter This was considered to be a key risk factor in Measures which might require delays at the Victoria pilot station or redirection to the Port Angeles pilot station. On the Victoria side, Constance Bank is an area of periodic high tidal currents and is not conducive for ships to drift while awaiting pilots and clearance to proceed inbound. Room for waiting anchorages is limited at Royal Roads and the area south of the TSS at Constance Bank is a popular fishing area. Language limitations were also considered to be a potential contributor to misunderstood intentions of vessels having to manoeuvre before/after embarking/disembarking pilots. For this reason also, any changes to the major TSS “roundabout” at Race Rocks was considered to be especially risky.

In both these concerns, the speed of the deep-sea ship is a factor. On the side of higher speed, of course, the consequences are higher, as is the noise, which is what we want to reduce by requiring lower engine revs and thus speed-through-the water. On the side of low speeds, this is also a risk for large ships as they lose a measure of manoeuvrability at slower speeds. This is not an issue generally in benign conditions, but in some conditions of wind and tidal current the difference between 10-11 knots and normal speed for certain ships may be significant.

4.2 Baseline Risk Assessment – Status Quo Haro Strait

The RA started with a baseline assessment of the status-quo risk in Haro Strait. While there are other areas of concern in the project (i.e. Strait of Juan de Fuca, Rosario Strait, Constance Bank, Boundary Pass), the current Haro Strait situation was presented as representing the highest risk of these areas. It is an area of close passing traffic at Kelp Reef, a Special Operating Area to manage a blind turn at Turn Point, and occasionally dense crossing traffic at Spieden Channel.

The Haro Strait status-quo was presented as one of the examples in the RA Template, scored by the facilitators. Nonetheless, many of the RA Team scored this independently, returning Risk Figures between 3 and 10, with an average of 6.5. This was considered to be an “acceptable” level of risk as it is what is currently being managed without a driving imperative for additional mitigations. Some of the RA Team went the next stage of the RA process in any case, proposing various mitigations such as a rescue tug stationed at Bedwell Harbour, enforcement of traffic lanes and small craft separation from deep sea traffic, and improved education (for recreational mariners). With such

mitigations applied the Risk Figure ranged from 3 to 8 with an average of 4.3. The variation in responses was fairly tight for this example, represented as a Standard Deviation of 1.9.[17] This step of mitigation was not treated consistently by the RA Team, and in any case it is the unmitigated situation in Haro Strait that should be our focus: this is the standard from which most of the Measures propose a departure in practice.

4.3 Relative Risk Assessment

It should be noted at this point the difference between the average "status-quo" Risk Assessment of 6.5 for Haro Strait determined by the RA Team and the Risk Figure of 8 determined from the record of accident probabilities in section 3.3. Due to the compressed timeline of the project, the RA Team did not have access to the accident record in determining either the probability or consequence of possible outcomes in their individual RA tables. They were asked to complete the table to the best of their ability based on professional experience and personal judgment. This baseline figure should be taken then not as a formal and precise expression of risk, but as a benchmark from which the resulting risk from proposed changes is notionally measured.

4.4 Average Risk Assessments

		Probability			Consequence			Risk			% Diff from
	Measure	Highest	Lowest<>0	Mean<>0	Highest	Lowest	Mean	Highest	Lowest	Mean	Status Quo
1	**0. Status Quo**										
2	0a. Current Operations in Haro Strait	2.0	1.0	1.6	5.0	3.0	3.9	10.0	3.0	6.5	0.00%
3	**1. Lateral Displacement**										
4	1a. Protected area E in Haro Str	4.0	1.0	2.8	5.0	3.0	3.8	16.0	3.0	11.1	69.41%
5	1b. SC route west of Haro Str lane	4.0	2.0	2.8	5.0	2.0	3.6	16.0	6.0	9.8	50.39%
6	1c. SOA - Haro Str One-way	5.0	1.0	2.9	5.0	3.0	4.0	25.0	3.0	12.2	85.88%
7	1d. SJDF - Shift outbound N of SB	4.0	1.0	2.6	5.0	3.0	4.1	20.0	3.0	11.0	68.24%
8	1e. SJDF - Shift all lanes further S of SB	3.0	1.0	2.5	5.0	1.0	3.8	15.0	1.0	9.8	50.59%
9	1f. Shift SJDF TSS off Sooke to south	4.0	2.0	2.8	5.0	3.0	3.9	20.0	6.0	11.2	70.59%
10	**2. Quiescence**										
11	2a.Quiet Periods	5.0	2.0	3.2	5.0	3.0	3.8	25.0	8.0	12.2	87.06%
12	2b. Schedule transits	5.0	3.0	3.6	5.0	3.0	3.9	25.0	9.0	14.3	118.82%
13	2c. Manage transits	5.0	3.0	3.7	5.0	3.0	3.9	25.0	9.0	14.6	123.53%
14	2d. Tidal transits	5.0	2.0	3.3	5.0	3.0	3.9	25.0	8.0	13.1	100.00%
15	**3. Redirection**										
16	3a. Redirection through Rosario	5.0	2.0	3.5	5.0	3.0	4.4	25.0	8.0	15.6	139.14%
17	3b. Conditional redirection to Rosario	4.0	1.0	3.2	5.0	3.0	4.4	20.0	3.0	14.3	118.82%
18	3c. One-way Rosario-Haro (I/O)	4.0	1.0	2.8	5.0	3.0	4.4	20.0	3.0	12.9	97.65%
19	**4. Speed Reduction**										
20	4a. Fixed SP Limit in Haro	3.0	2.0	2.5	5.0	3.0	4.0	15.0	6.0	10.3	57.65%
21	4b. Circumstantial SP Limit in Haro (SRKW)	3.0	2.0	2.6	5.0	3.0	4.0	15.0	6.0	10.6	62.35%
22	4c. Conditional SP Limit in Haro (Vessels)	3.0	2.0	2.4	5.0	3.0	4.0	15.0	6.0	9.6	47.06%
23	4d. Circumstantial SP Limit in SJDF	5.0	1.0	2.5	5.0	2.0	3.8	20.0	2.0	10.3	57.65%

Table 3. Initial Risk Assessments by Measure, from Individual RA Tables

The initial RA results from individual responses is shown in Table 3. Examination of this table indicates that the average risk by Measure ranges from 50% to 123% higher than the status quo, with risk figures of 9.8 to 15.6.

The question was posed to the RA Team: what is the maximum tolerable risk? There was no firm consensus or rationalized position on this, but in practice the RA Team

[17] The meaning of this is that the Average figure +/- the Standard Deviation represents 68.2% of the responses. As explained earlier, the sample size is not large for this kind of statistical treatment, so this is merely informative of the spread of values.

seemed to regard the Haro Strait status-quo as defining the (near) maximum tolerable risk. In the final analysis, only four Measures with a Mitigated Risk Figure greater than the status quo were deemed acceptable and only one of these was over 7.3.

It should be noted that the RA Team members proposed Probability and Consequence figures for each Measure and the Risk Figure was calculated from this. The Highest, Lowest and Median risks in Table 3 are as combined by the RA Team members individually and do not represent an overall Worst Probability x Worst Consequence match. The resulting Risk Figure thus required no separate judgement. The judgement of maximum acceptable risk, however, may have been influenced by the terminology in the scale at Table 4. This mirrors the PRMM scale for Consequence and has the upper-right/lower-left sets of six cells as the extremes of the scale. Other versions of this chart are not as graduated between green and red, with a broader yellow band in between Low and Extreme.

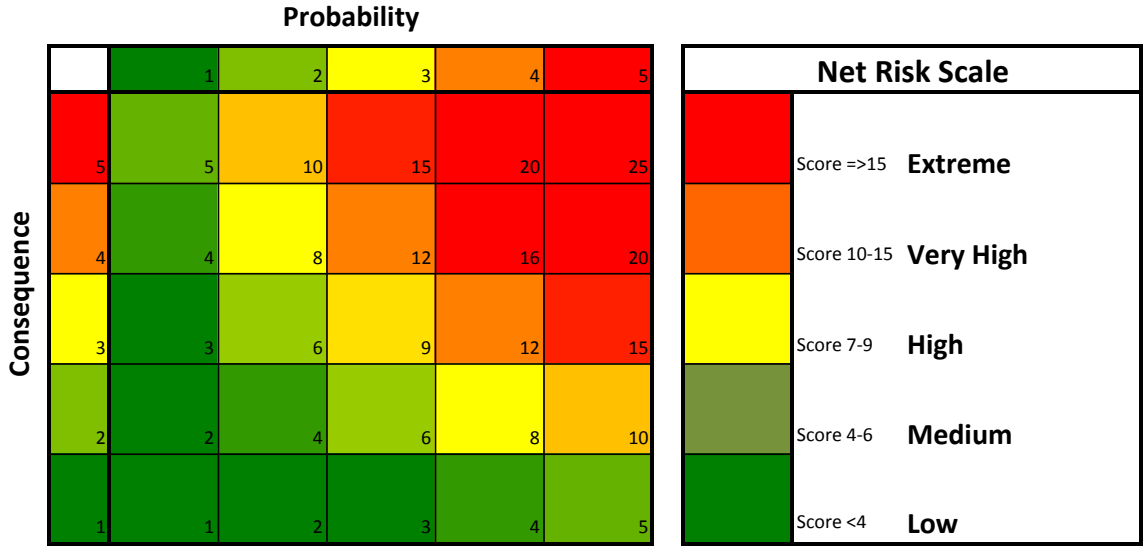

Table 4. Net Risk Scale

It will be seen that in several measures the maximal probabilities and consequences are extreme at “5”. RA Team members were instructed to think of worst case outcomes possibly attributable to the implementation of proposed Measures and to rate these by Probability and Consequence. It is believed in some cases, they may have considered worst Probability and worst Consequence separately, without relating the probability directly to the consequence. This would in some cases have resulted in an exaggeration of the overall risk, as with the proposal of highest probability and highest consequence together (that is 5x5=25 = multiple deaths, massive environmental damage, material repairs in the greater than $10M and/or significant adverse publicity on a national scale ***every year***). Clearly, however, in very plausible outcomes the risk could be extreme with little opportunity for doubt: if just one collision between a deep-sea ship and a recreational boater in Haro Strait each three years resulted in a death and serious injuries, this would figure as 4 x 4 = 16, i.e. “Extreme.” Some of this uncertainty on the assessment could have been resolved with an interim step in which the RA Team devised an agreed set of outcomes for each Measure, but the timeline of the project and restricted focus did not permit this refinement.

4.5 Mitigations and Residual Risk

A large number of mitigations were proposed in the course of the individual risk assessments. These have been consolidated in a table by Measure at Annex C. The mitigations were not discussed in any detail as they are largely self-evident. In some cases, the mitigations were edited to be able to group like mitigations.

The mitigations fall into 8 broad categories:

1. CCG – those mitigations requiring some sort of enforcement of directions to shipping. This is noted as different from VTS as it is beyond traffic services per se, even though both VTS and enforcement are shared by CCG and TC.[18]
2. DFO – those mitigations requiring further scientific work or determination of whale presence.
3. Education – those mitigations suggesting a campaign of public awareness and amateur or professional training in navigation practices.
4. Pilots – those mitigations requiring amendments to pilotage practice, scheduling or regulation. These mitigations ranged from actions that could be managed by pilots themselves to sweeping changes to the pilotage scheme in the area.
5. TC – those mitigations suggesting changes in vessel equipment carriage or classification to serve the purposes of noise mitigation.
6. TSS – those mitigations requiring changes to the Traffic Separation Scheme. As Haro Strait and the Strait of Juan de Fuca are binational straits containing IMO-approved TSS, these measures presume a large effort in high-level negotiation and approval.
7. Tugs – those mitigations requiring either stand-by, escort or tethered tugs in various locations.
8. VTS – those mitigations requiring changes to the practice of Vessel Traffic Services in the area. This was is distinct from the on-water role of the CCG in enforcement or the communications services element of MCTS, and was the largest group of mitigations, ranging from geofencing to direct coordination of traffic. Some of the advisory mitigations related to VTS are within the current capability and mandate of VTS.

It will be seen from inspection of the table at Annex C that 4 to 12 mitigations were proposed collectively by the RA Team for each Measure. Some mitigations were proposed for unique Measures, while others were proposed for up to 9 Measures. The most common mitigations were, in order: rescue tugs on standby, geofencing (i.e. AIS tracking alarms on deviations of track or speed), and education of small craft operators. Most of the mitigations fell in the domain of VTS (24), followed by TSS (16) and Pilots (9). All of the proposed mitigations, with the possible exception of Rescue Tug on Standby, were oriented towards the reduction of Probability, not Consequence.

Once the mitigations were applied, the RA Team members assessed the Mitigated (or Residual) Risk as shown in Table 5. In most cases the assessment was due to a reduction in perceived Probability, although in a few isolated cases the Consequence was seen to drop also.[19] The Mean Mitigated Risk (apart from the Status Quo situation)

[18] In some cases in Canada such enforcement would be a police mandate (RCMP)
[19] An example of the difference would be such as this: against the risk of a tanker grounding in Haro Strait, the potential mitigation of a tethered escort tug would diminish Probability of this

ranges from marginally below the Mean Status Quo Risk to 76% higher than this baseline risk. Of the 18 Measures, 10 result in a Risk Figure of 8 or more. The standard deviation for these results ranged from 3.3 to 5.5, demonstrating a fairly wide variation of judgment in many cases.

It should be noted that the full range of mitigations was assembled from individual reponses. None of the RA Team members actually proposed or applied all of these Mitgations to their own risk assessments. It is possible that if the RA Team had considered and applied the full range of mitigations to the problem, the Mean Mitigated Risk would have been somewhat lower than the average of the individually-mitigated risks. Time available for the project and for this particular workshop did not permit this additional round of assessment.

		Mitigated Probability			Mitigated Consequence			Mitgated Risk				% Diff from
	Measure	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Std Dev	Status Quo
1	**0. Status Quo**											
2	0a. Current Operations in Haro Strait	2.0	1.0	1.1	5.0	3.0	3.9	8.0	3.0	4.3	1.9	
3	**1. Lateral Displacement**											
4	1a. Protected area E in Haro Str	3.0	1.0	1.8	5.0	3.0	3.9	12.0	3.0	7.2	3.7	10.26%
5	1b. SC route west of Haro Str lane	3.0	1.0	1.8	5.0	2.0	3.6	12.0	3.0	6.5	3.6	-0.70%
6	1c. SOA - Haro Str One-way	4.0	1.0	2.3	5.0	3.0	3.9	20.0	3.0	9.4	5.2	44.87%
7	1d. SJDF - Shift outbound N of SB	3.0	1.0	2.0	5.0	3.0	4.1	15.0	3.0	8.2	4.5	25.87%
8	1e. SJDF - Shift all lanes further S of SB	3.0	1.0	1.8	5.0	1.0	3.7	12.0	1.0	7.0	3.7	7.69%
9	1f. Shift SJDF TSS off Sooke to south	3.0	1.0	1.9	5.0	3.0	4.0	12.0	3.0	7.8	3.8	19.23%
10	**2. Quiescence**											
11	2a.Quiet Periods	4.0	1.0	2.1	5.0	3.0	3.8	20.0	3.0	8.2	5.2	25.64%
12	2b. Schedule transits	4.0	2.0	2.7	5.0	3.0	4.0	20.0	6.0	10.8	5.1	66.67%
13	2c. Manage transits	4.0	2.0	2.7	5.0	3.0	4.0	20.0	6.0	10.8	5.1	66.67%
14	2d. Tidal transits	4.0	1.0	2.4	5.0	3.0	3.9	20.0	3.0	9.8	5.4	50.00%
15	**3. Redirection**											
16	3a. Redirection through Rosario	4.0	2.0	2.5	5.0	3.0	4.4	16.0	6.0	11.2	5.5	72.03%
17	3b. Conditional redirection to Rosario	4.0	1.0	2.5	5.0	3.0	4.5	16.0	3.0	11.4	5.3	75.64%
18	3c. One-way Rosario-Haro (I/O)	4.0	1.0	2.3	5.0	3.0	4.4	16.0	3.0	10.2	5.2	56.41%
19	**4. Speed Reduction**											
20	4a. Fixed SP Limit in Haro	2.0	1.0	1.6	5.0	3.0	4.0	10.0	3.0	6.5	3.3	0.00%
21	4b. Circumstantial SP Limit in Haro (SRKW)	3.0	1.0	1.8	5.0	3.0	4.1	12.0	3.0	7.3	3.6	11.54%
22	4c. Conditional SP Limit in Haro (Vessels)	2.0	1.0	1.6	5.0	3.0	4.0	10.0	3.0	6.5	3.3	0.00%
23	4d. Circumstantial SP Limit in SJDF	5.0	1.0	2.1	5.0	2.0	3.8	20.0	2.0	8.3	5.5	26.92%

Table 5. Mitigated Risk Assessments, by Measure, from Individual RA Tables

4.6 Suitability for Further Examination

Following the review of the compilation of the individual Risk Assessments as presented above, the RA Team engaged in a discussion of which Measures could possibly warrant further examination or development. The question was initially phrased with a number of qualifiers: Given the range of responses, and recognizing the spread of assessed risk, and in consideration of the effort involved in implementing the various Measures to reduce ship-generated noise in the Salish Sea, are any of the Measures sufficiently close to acceptable risk levels as to warrant further examination?

Among the qualifiers was the issue of implementation effort. While it was not the mandate of this project to consider the impact to industry of implementing these

outcome, whereas a potential mitigation of improved oil spill response would reduce the Consequence of such an outcome.

Measures, nor the cost in administrative effort to negotiate regulatory and procedural changes, the issues surrounding implementation were used to gauge the relative difficulty of effecting each of the Measures. RA Team members were asked to indicate what were the key issues, and then to rank the difficulty on an ascending scale from 1 to 5, ranging from days/$10K to years/$10M+. The collated, paraphrased and grouped Implementation Issues are tabulated in Annex E by Measure. The leading issues for implementation are Consultation (with various groups, covering all Measures), Bi-national Agreement (14), Coast Pilot/Sailing Directions Updates (12), Procedures Changes and VTS Staff Training (11), Supply Chain Disruptions (8), and IMO TSS Approval (6). Individual Measures had from 7 to 12 issues associated with implementation, not all mentioned by each RA Team member. The net assessment of implementation effort suggests that at least 10 of the Measures would require "Extensive" (months/$100K+) effort or greater.

The discussion of Measures warranting further investigation was impeded by the complexity of the qualified question, and the difficulty of hypothesizing a risk appreciation encompassing all of the variously proposed risk mitigations that may or may not lead to a further-diminished residual risk. Accordingly, after review and discussion of the Measures, the question was put simply to the RA Team by Measure:

"Does this Measure warrant further examination?"

The results of this poll are presented with the Mitigated Risk and Implementation Scores in Table 6 below.

The Measures deemed ***acceptable*** for further examination, towards possible implementation are:

1a – the Whale Protection Zone in east Haro Strait;
1b – the small craft route up the west side of Haro Strait;
1e – the shift of the TSS further south at Swiftsure Bank (SJDF entrance); and
4a-4d – all the Speed Reduction options for Haro Strait and SJDF

The Measures deemed ***unacceptable*** for further examination and development are:

1c – extending the Turn Point SOA practices to all of Haro Strait;
1d – shifting the outbound lane at the SJDF entrance north of Swiftsure Bank;
1f – shifting the SJDF TSS south off Sooke;
2a-2d – all of the Quiescence options; and
33-3c – all of the Redirection options through Rosario Strait.

	Measure	Mitgated Risk				Implementation			Examine Further?
		Highest	Lowest	Mean	Std Dev	Highest	Lowest	Mean	
									1=Y; 0=N
1	**0. Status Quo**								
2	0a. Current Operations in Haro Strait	8.0	3.0	4.3	1.9	2.0	1.0	1.2	1
3	**1. Lateral Displacement**								
4	1a. Protected area E in Haro Str	12.0	3.0	7.2	3.7	5.0	1.0	2.8	1
5	1b. SC route west of Haro Str lane	12.0	3.0	6.5	3.6	4.0	1.0	2.7	1
6	1c. SOA - Haro Str One-way	20.0	3.0	9.4	5.2	5.0	2.0	3.5	0
7	1d. SJDF - Shift outbound N of SB	15.0	3.0	8.2	4.5	5.0	2.0	3.8	0
8	1e. SJDF - Shift all lanes further S of SB	12.0	1.0	7.0	3.7	5.0	3.0	4.0	1
9	1f. Shift SJDF TSS off Sooke to south	12.0	3.0	7.8	3.8	5.0	3.0	4.0	0
10	**2. Quiescence**								
11	2a.Quiet Periods	20.0	3.0	8.2	5.2	5.0	2.0	2.9	0
12	2b. Schedule transits	20.0	6.0	10.8	5.1	5.0	3.0	3.6	0
13	2c. Manage transits	20.0	6.0	10.8	5.1	5.0	2.0	3.6	0
14	2d. Tidal transits	20.0	3.0	9.8	5.4	5.0	2.0	3.5	0
15	**3. Redirection**								
16	3a. Redirection through Rosario	16.0	6.0	11.2	5.5	5.0	4.0	4.7	0
17	3b. Conditional redirection to Rosario	16.0	3.0	11.4	5.3	5.0	2.0	4.3	0
18	3c. One-way Rosario-Haro (I/O)	16.0	3.0	10.2	5.2	5.0	2.0	4.3	0
19	**4. Speed Reduction**								
20	4a. Fixed SP Limit in Haro	10.0	3.0	6.5	3.3	5.0	1.0	2.7	1
21	4b. Circumstantial SP Limit in Haro (SRKW)	12.0	3.0	7.3	3.6	5.0	2.0	2.9	1
22	4c. Conditional SP Limit in Haro (Vessels)	10.0	3.0	6.5	3.3	5.0	2.0	3.3	1
23	4d. Circumstantial SP Limit in SJDF	20.0	2.0	8.3	5.5	5.0	2.0	3.0	1

Table 6. Mitigated Risk Results and Implementation Scores

It will be noted from inspection of Table 6 that all of the acceptable Measures except one have mean Risk Figures of 7.3 or less, demonstrating some flexibility from the (unmitigated) Status-Quo mean of 6.5. All of the unacceptable Measures except three have mean Risk Figures of 9.4 or above. The exceptions in each case have Risk Figures between 7.8 (unacceptable) and 8.3 (acceptable); that is, there is an overlapping band of Risk Figures in this range where the decision of whether to further examine Measures was not solely determined by the Residual Risk Figure. These cases are shaded yellow in the right hand column of Table 6. This suggests that the “tolerable risk level” could be generalized to be in the order of 8, and that other factors (scope of required mitigations, implementation difficulties) may have influenced the outcome in the range of Risk Figures from 7.8 to 8.3. It may be that a more focused and comprehensive consideration of mitigations could result in further shifts of risk assessment in these cases, or perhaps others also.

It should also be noted that the Yes-No vote related above was not in all cases much more than a simple majority; in a few cases the vote was very close, with some RA Team members abstaining. However, in all the cases where the vote was within 2 votes of changing the result, these are shown here as “Yes” votes. The “No” votes were all more definite judgments in this process. Nonetheless, in the opinion of the facilitators, it might be possible upon review and refinement of the Measures, that some Risk Assessments would shift and result in a positive vote. Measure 1f – Shifting TSS South at Sooke – is the one refusal that overlaps acceptable Risk Figures and thus might be suitable for re-evaluation notwithstanding the vote result. It is believed that this Measure’s result was heavily influenced by the dislike of disturbing the Race Rocks

roundabout, so that the Measure might have been acceptable if an alternate solution could achieve the lateral separation objective without this negative change.

5. INTERPRETATION OF RESULTS

This was a high level risk assessment with a tight timeline, so some qualification of the results are appropriate. First, it should be acknowledged that the RA Team members gave generously of their time and that the time spent doing the “homework” was greatly appreciated as helping to advance the project to completion in a short time. In retrospect the RA Process could have benefitted from an additional round of examination, but the timeline did not permit this. However, within the restricted mandate of the project, it is considered that the result fairly represents the collective experience of nautical professionals regarding the risk of the proposed noise-reduction Measures. Several specific qualifications are outlined below.

5.1 Imprecision in Specification of Measures

The specific Measures to be assessed were defined only loosely, in the sheet of instructions provided with the RA Table as “homework” for the RA Team. This was sufficient for the generality of the result achieved here, but further elaboration and precision would be required to do a proper “Implementation” assessment.

5.2 Imprecision of Outcomes/Factors Examination

The Risk Assessment conducted here was based on generalized risk scenarios related to each Measure. For greater confidence in the results, a standardized set of specific outcomes for each Measure would have to be developed and used by each RA Team member. This would resolve any doubt as to the combination of Probabilities and Consequences of different outcomes.

5.3 Variation in Results

The variation of Mitigated Risk Factors is a positive outcome in demonstrating a range of perspectives on the suggested Measures. The down-side of this is that it leaves doubt as to the actual risks involved and the true threshold of risk tolerance. A three-stage PRMM could have resolved some of this by providing greater definition in the Measures, Outcomes and also providing some prior orientation in the recorded frequency of accidents in the study area. This might have set a better baseline of common appreciation from which to gauge the degree of risk increases subsequent to hypothetical Measures implementation. In addition, a more extended process would also permit a more robust discussion of available mitigations and subsequent application of a standardized set to get a more consistent Residual Risk.

5.4 Effort for Implementation

Clearly, many of the issues for implementation would require considerable effort. The need for consultation is paramount and must include a wide variety of stakeholders. The fact that only a limited and focused representation was invited at this RA does not reflect ignorance of other interested parties but only the restricted scope of this preliminary process. Apart from this, the RA Team identified a generous range of implementation

issues which should form a solid basis for further examination. Certain members of the RA Team with personal experience also cautioned that the effort of redrawing IMO-approved Traffic Separation Schemes is not to be under-estimated.

5.5 Political Non-Starters

Among the Measures rejected by the RA Team were all of the suggestions of redirecting traffic through Rosario Strait. These Measures rated highest on both the Residual Risk calculation and also on the Implementation Difficulty scale. The suggestion calls for longer redirection of Canadian-bound traffic from a bi-national strait to US internal waters, with implications of more complex pilotage arrangements, tighter navigation, displacement of the problem from one area to another, and possibly lack of routing clarity for ships arriving at the Race Rocks TSS junction. All of this spells unacceptable risk. Furthermore, these Measures involve the United States accepting significant risk to solve a problem for which other, simpler measures exist. In the end, apart from the RA, this was felt to be a political non-starter.

6. FUTURE STEPS

This Risk Assessment was a preliminary step toward identification and sorting of potential measures to reduce ship-noise impacts on the SRKW. A number of Measures have been examined and judged acceptable for further consideration. This judgement has been on the basis of navigational safety, informed also by the potential difficulty of implementation. Others have been rejected on similar grounds.

In further consideration of the possible implementation of ship-noise reduction measures in the Salish Sea, the following is recommended:

a. That the process allow ample timelines to engage appropriate representation;
b. That a wider representation allow a broad-based risk appreciation including economic impacts and social/cultural factors;
c. That the RA process include an interim step to better define Measures with navigational precision and details of implementation practices;
d. That DFO provide representatives to better clarify the relative benefits of modified Measures; and
e. That detailed accident records be used to provide an accurate assessment of current risk profiles.

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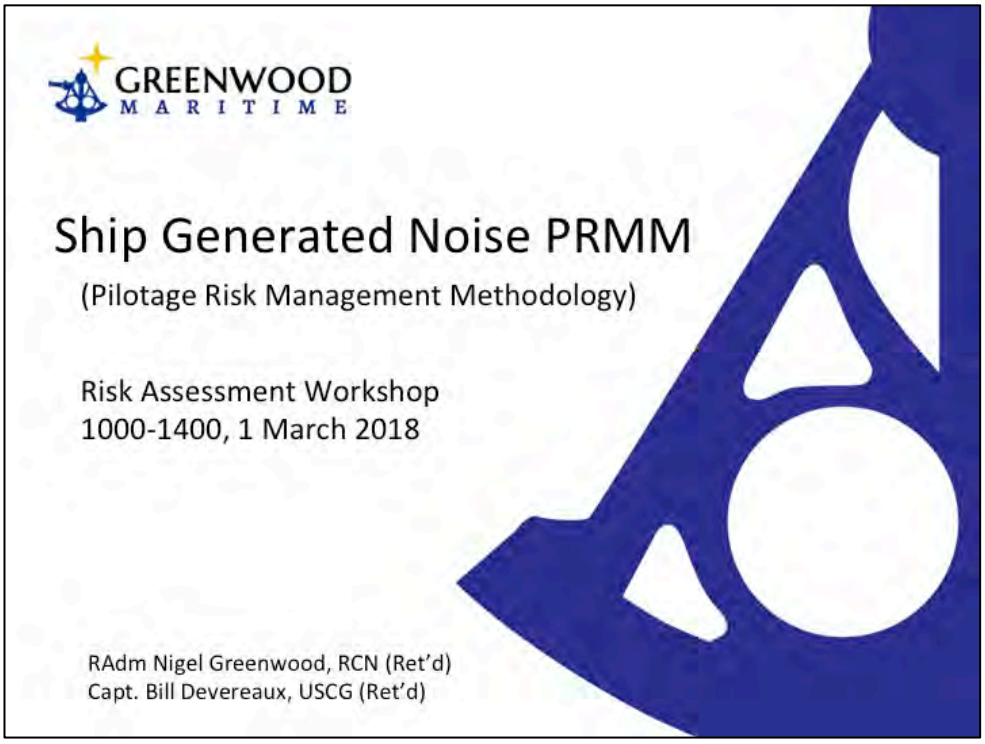
ANNEX A. PARTICPANTS

Name	Org	Phone	Email	7 Feb	1 Mar
Nigel Greenwood	Greenwood Maritime	(250) 507-8445	nsg@greenwoodmaritime.com	Y	Y
Bill Devereaux	Devereaux Consulting	(206) 914-8362	devereauxconsulting@comcast.net	Y	Y
Sol Kohlhaas	Andeavor	(813) 294-9730	sol.b.kohlhaas@andeavor.com	Y	by phone
Robin Stewart	BC Coast Pilots	(604) 688-0291x308	pres@bcpilots.com	Y	
Roy Haakonson	BC Coast Pilots	(604) 688-0291	rchaakonson@shaw.ca	Y	Y
Paul Devries	BC Coast Pilots	604-688-0291x307	pbd@bcpilots.com	Y	Y
Kent Reid	Canadian Coast Guard	(604) 319-2202	kent.reid@dfo-mpo.gc.ca	Y	Y
Art Statham	Canadian Coast Guard	(250) 812-2292	art.statham@dfo-mpo.gc.ca	Y	Y
Robert Lewis-Manning	Chamber of Shipping of BC	(604) 681-2351	robert@cosbc.ca	Y	Y
Greg Wirtz	CLIA	(604) 681-9515	gwirtz@clia-nwc.com	Y	
Donna Spalding	CLIA		dspalding@clia-nwc.co		Y
Phillip Nelson	Council of Marine Carriers	(604) 687-9677	pnelson@comc.cc	Y	Y
Paulo Ehkebus	Pacific Pilotage	(604) 666-6771	pehkebus@ppa.gc.ca	Y	
Eric Von Brandenfels	Puget Sound Pilots	(206) 595-8209	president@pspilots.org	Y	
Ivan Carlson	Puget Sound Pilots		icarlson@pspilots.or		Y
Jostein Kalvoy	Puget Sound Pilots	(206) 909-6938	jkalvoy@pspilots.org	Y	
Scott Galloway	SFC	(778) 554-5325	sgalloway@shipfed.ca		
Bill McKinstry	SFC	(778) 839-7800	bmckinstry@shipfed.ca	by phone	
Chad Allen	SFC				by phone
Sonia Simard	SFC		ssimard@shipfed.c		by phone
Khushru Irani	Transport Canada	(604) 775-7080	khushru.irani@tc.gc.ca	Y	Y
Marie-Helene Roy*	Transport Canada	(613) 991-3134	marie-helene.roy@tc.gc.ca	by phone	Y
Jeff Pelton	Transport Canada	(604) 790-0899	jeff.pelton@tc.gc.ca	Y	Y
Laird Hail	U.S. Coast Guard	(206) 217-6046	laird.h.hail@uscg.mil	Y	Y
Krista Trounce	VFPA	(604) 353-3127	kbtrounce@portvancouver.com	Y	Y

ANNEX B. WORKSHOP BRIEF



Project Objective:

To describe and assess, using the PRMM methodology, the *navigation* safety risks and issues associated with implementing potential measures to mitigate impacts on SRKW populations in the Salish Sea

Proposed "Measures"

1. ***Lateral displacement of vessel traffic through regulation, guidelines or the redesign traffic separation schemes***
2. ***Creation of periods of quiescence accomplished directly or through clustering of vessel transits***
3. ***The re-direction of some vessel traffic through alternate routes (Rosario Strait)***
4. ***Reducing vessel speed***

**defined in greater detail later*

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CAVEATs:

This project is ***not*** about:

1. Efficacy of the proposed Measures (science programmes are addressing this)
2. Economic impact of potential Measures (subsequent TC initiatives will cover this)
3. Collaborative mechanisms for addressing vessel traffic management (a separate TC project is addressing this)
4. Consultation with interested coastal communities (future outreach and engagement will address this)

This project ***is*** about:

1. Hypothesizing in greater (operational) detail the proposed Measures
2. Outlining the issues involved in implementing these Measures
3. Determining the (operational) risk factors associated with the proposed Measures
4. Determining if mitigations of such risk factors is required or possible (without eliminating benefits of the proposed Measures)
5. Arriving at a qualitative Risk Assessment of implementing the proposed Measures

**** A lot of this project is necessarily "hypothetical" as not all the science is complete***

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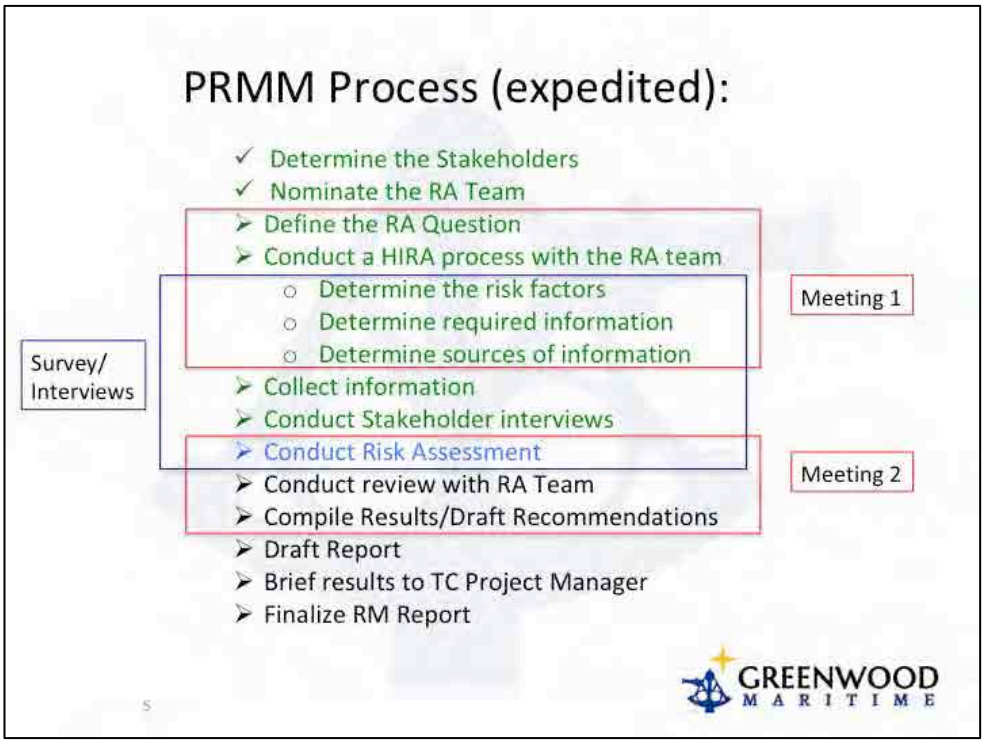
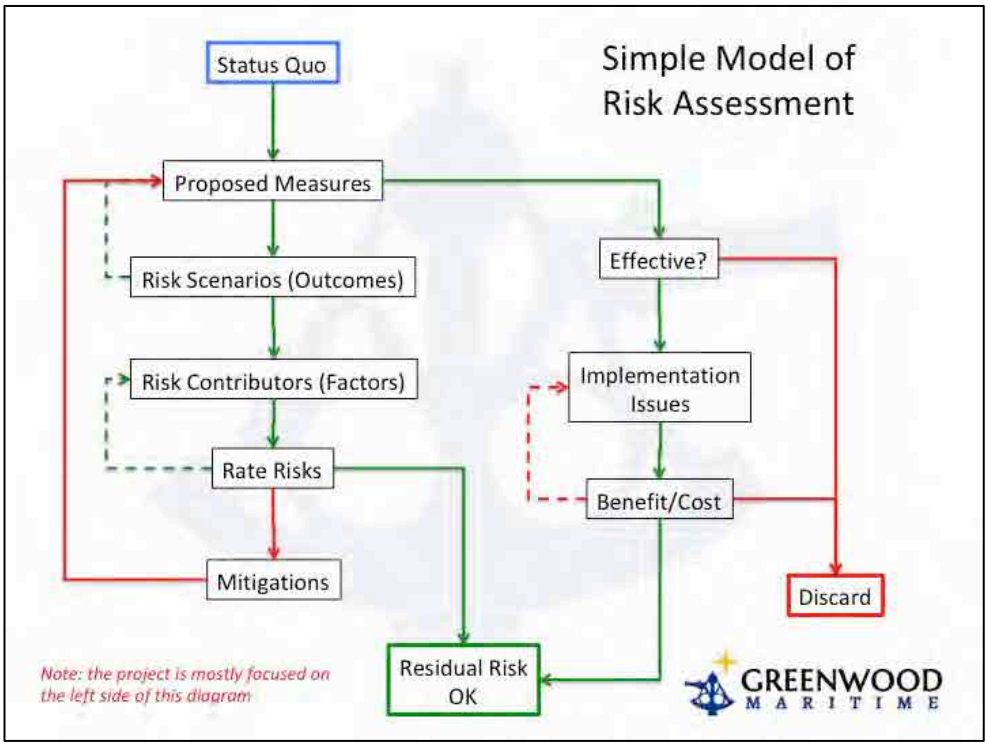

PRMM Process (expedited):
✓ Determine the Stakeholders
✓ Nominate the RA Team
➢ Define the RA Question
➢ Conduct a HIRA process with the RA team
○ Determine the risk factors
○ Determine required information
○ Determine sources of information
Meeting 1
Survey/ Interviews
➢ Collect information
➢ Conduct Stakeholder interviews
➢ Conduct Risk Assessment
➢ Conduct review with RA Team
➢ Compile Results/Draft Recommendations
Meeting 2
➢ Draft Report
➢ Brief results to TC Project Manager
➢ Finalize RM Report
GREENWOOD MARITIME


Simple Model of Risk Assessment
Status Quo
Proposed Measures
Risk Scenarios (Outcomes)
Risk Contributors (Factors)
Rate Risks
Mitigations
Effective?
Implementation Issues
Benefit/Cost
Discard
Residual Risk OK
Note: the project is mostly focused on the left side of this diagram
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Hazard Identification and Risk Assessment (to discuss)

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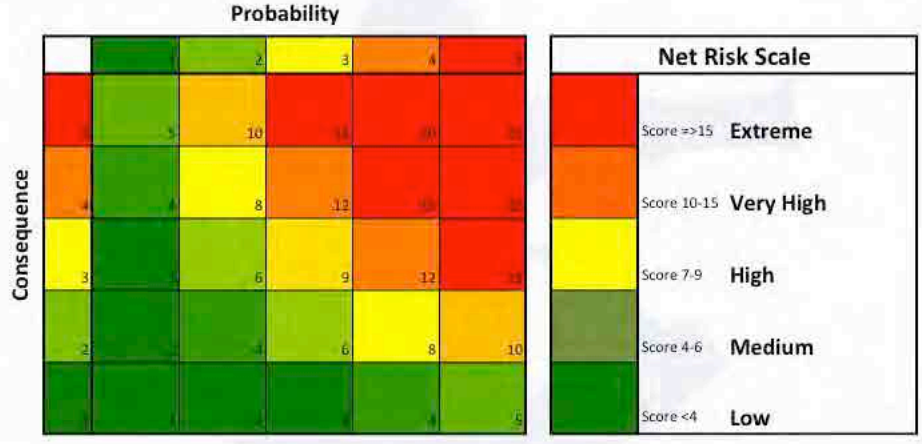
Net Risk Scale:

- *what is a tolerable level of risk?*



e.g.: 9 = some people with long-term injuries, once every 10 years;
10 = incidence of multiple deaths incident at intervals of more than 10 years
12 = incidence of single death/multiple injuries, once every 10 years

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Standard Criteria of Probability and Consequence

PROBABILITY	
5 Highly Probable	
4 Probable	Expected that the event will occur OR at least once over a period of three years
3 Possible	The event could occur over a period of 10 years
2 Unlikely	It is not expected that the event will occur over a period 10 years
1 Improbable	

CONSEQUENCE/SEVERITY	Human	Property	Vessel(s)	Environmental	Reputation
5 Extreme					
4 Very High	Eight-month acre fatalities people with serious long term injury, permanent	Damage to facilities is such that operations cease for up to one month or financial loss of $5 - $10 million	Vessel sustains damage significant enough to result in towing to dry dock and loss of operations for one month	Incident causes medium term harm to the environment (i.e. damage lasts up to one month)	Front page adverse national media coverage and intervention international sources
3 High	Some people with serious long term injury and multiple minor injuries	Damage to facilities is such that the operations cease for up to two weeks or financial loss of $1 - $5 million	Vessel sustains significant damage with dry docking and loss of operations for two weeks	Incident causes medium term harm to environment (i.e damage lasts up to two weeks)	Intermittent adverse national media coverage
2 Medium	One person with serious long term injury. Some minor injuries	Damage to facilities cause operations to cease for up to one week or financial impact of $500,000 - $1 million	Vessel sustains damage resulting in loss of operations for one week	Incident causes short term harm to the environment (i.e. damage lasts no longer than one week).	Sustained front page adverse local media coverage. Board and Ottawa receive complaints from CS and Major Clients.
1 Low					

Ref: PRMM Manual
TP 13741E, 2010

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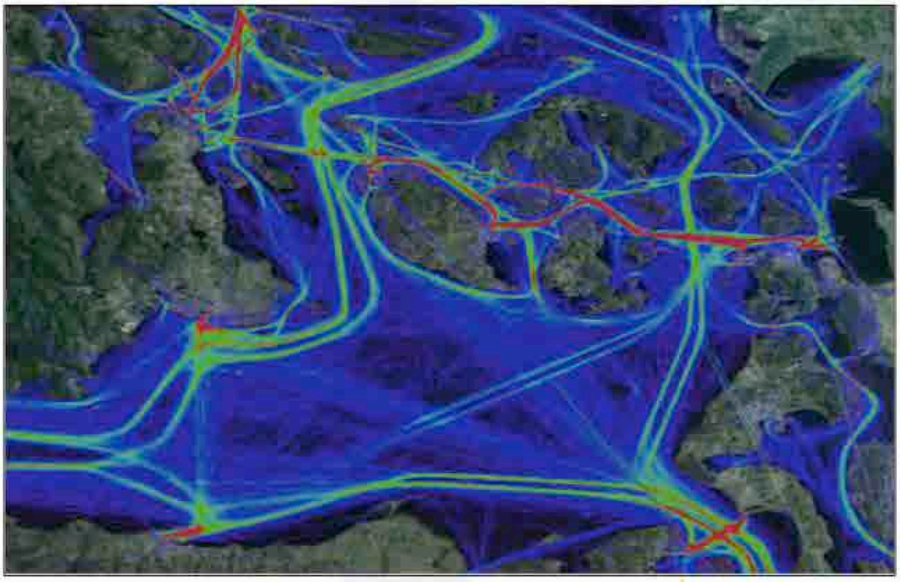
Traffic Patterns (Aug)



(courtesy USCG)

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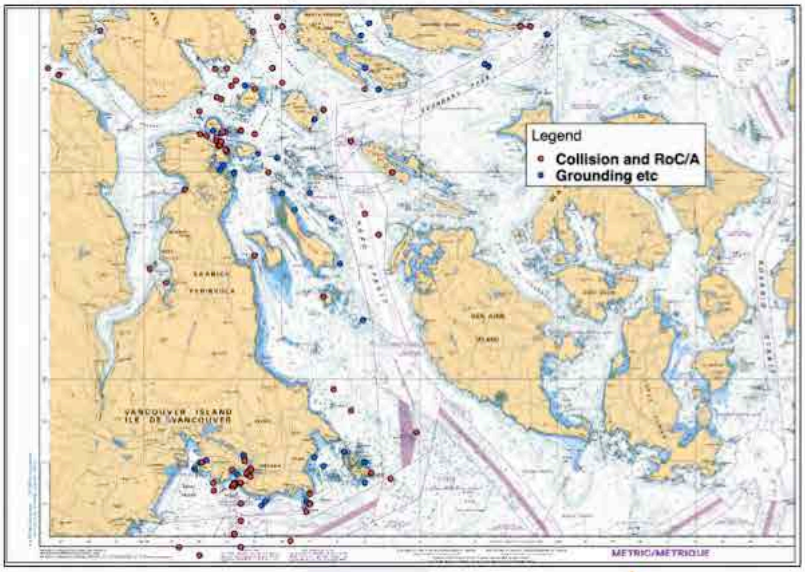
TSB Canada Incidents/Accidents 1997-2016



This plot show Collisions and Risks of Collisions and Allisions, Grounding and Risks of Groundings, Touching Bottom etc

GREENWOOD MARITIME

Probability Benchmarking

Geographical Filter:
48.33N < Lat > 48.83N
122.67W < Long > 123.33W
(Haro, Boundary, Rosario)

US Stats 1992-2017
498 Incidents
52 Allisions, Collisions, Groundings (11 FV, 17 PV, 1 SV, 9 T, 3 MV)
MV: 3/25 years = 0.12/yr ~ "3" on Probability Table (once every 10 yr)
FV: 11/25 years = 0.44/yr ~ "4" on Probability Table (once every 3 yr)
FV/PV/SV/T Collision/Grounding: 28/25 years = 1.12/yr ~ "5" on Prob Table (once per yr)

Cdn Stats 1997-2016
166 Incidents
31 Allisions, Collisions, Groundings (15 FV, 3 PV, 0 SV, 3T&B, 5 MV)
MV: 5/20 years = 0.25/yr ~ "3" on Probability Table (at least once in 10 yr)
FV: 15/20 years = 0.75/yr ~ "4" on Probability Table (once every 3 yr)
FV/PV/SV/T Collision/Grounding: 21/20 years = 1.1/yr ~ "5" on Prob Table (once every 3 yr)

*** Note this includes "Risk of Grounding", etc*

GREENWOOD MARITIME

Risk Benchmarking: Linking of Prob and Conseq

Say Probability of MV (deep sea) grounding ~ 0.12/yr ~ "3" on Prob table

- This is 3 over 25 years
- Say #1/3 grounded with minor fuel spill from bunkers
  - ~ 0.04/yr ~ "1-2" on Prob table, "3-5" on Conseq table,
  - Risk = "3-10"
- Say #2/3 grounded with no damage, 1 serious pers injury
  - ~ 0.04/yr ~ "1-2" on Prob table, "2" on Conseq table,
  - Risk = "2-4"

Say Probability of FV grounding ~ 0.44/yr ~ "4" on Prob table

- This is 11 over 25 years
- Say 8 ground with no damage, minor injuries
  - ~ 0.32/yr ~ "3-4" on Prob table, "1" on Conseq table
  - Risk = "3-4"
- Say 1 grounds with minor fuel spill, loss of life
  - ~ 0.04/yr ~ "1-2" on Prob table, "4" on Conseq table
  - Risk = "4-8"

Result: Greatest hypothetical risk is "8-10" ~ "High-Very High"

Ground truth in Haro Strait: no Deep Sea groundings reported in last 20 years

GREENWOOD MARITIME

Refinement/Definition of Measures

(0) Status Quo – Haro Str

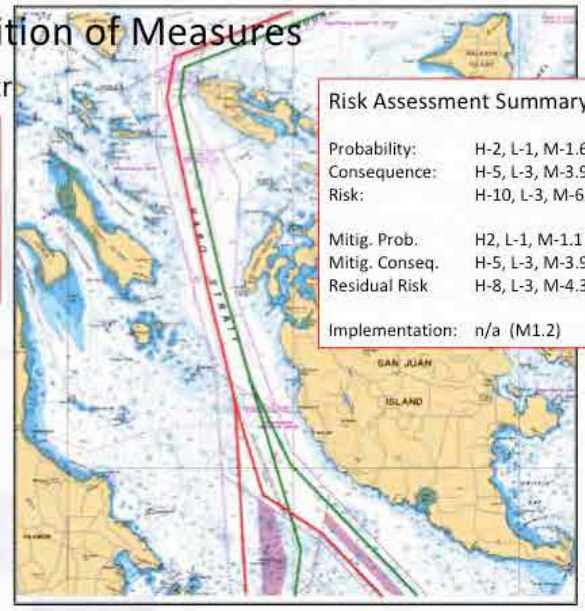
- two-way traffic
- SOA at Turn Point
- Confluence at Beaumont Sh
- Cooperative VTS CanUS
- Mixed deep-sea/coastal/ recreational traffic

Risk Scenarios:

- Small traffic crossing/ merging with deep sea
- Grounding at Kelp Rf
- Collision at Turn Pt

Risk Factors:

- Weather
- Currents
- Proximity to shore
- Proximity of other ships



Risk Assessment Summary:

Probability:	H-2, L-1, M-1.6
Consequence:	H-5, L-3, M-3.9
Risk:	H-10, L-3, M-6.5
Mitig. Prob.	H2, L-1, M-1.1
Mitig. Conseq.	H-5, L-3, M-3.9
Residual Risk	H-8, L-3, M-4.3
Implementation:	n/a (M1.2)

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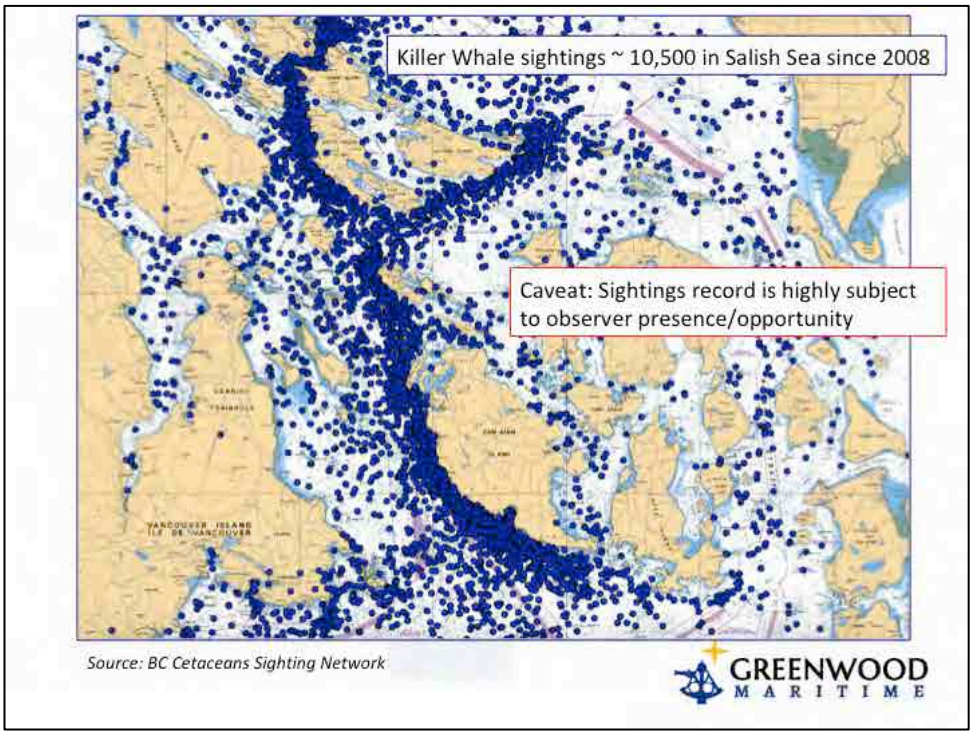
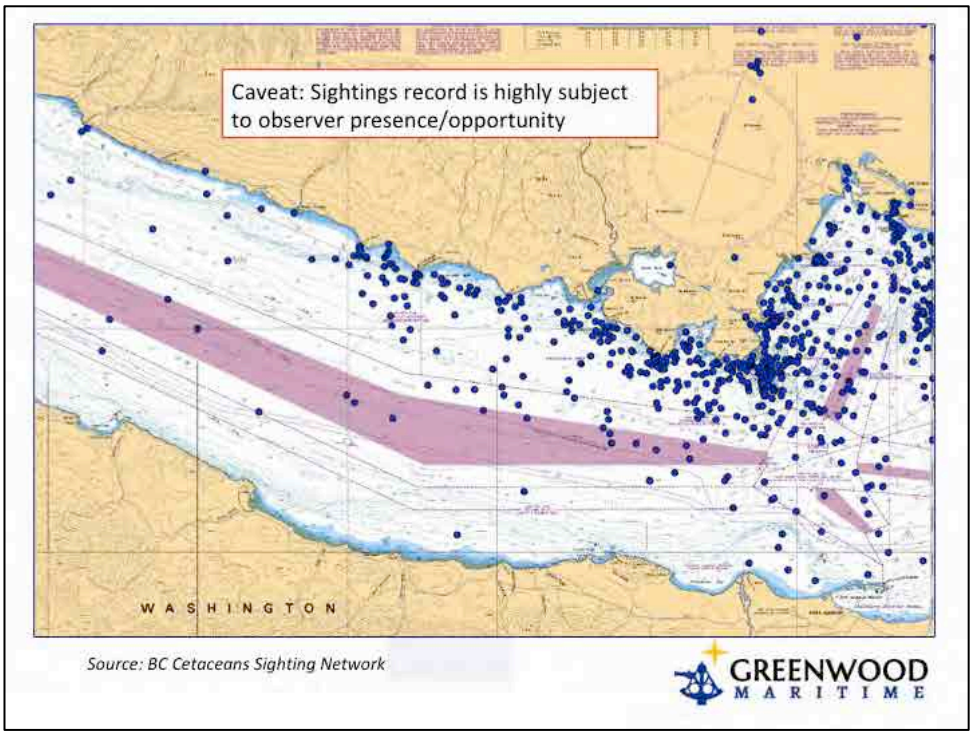

Killer Whale sightings ~ 10,500 in Salish Sea since 2008
Caveat: Sightings record is highly subject to observer presence/opportunity
VANCOUVER ISLAND
ÎLE DE VANCOUVER
Source: BC Cetaceans Sighting Network
GREENWOOD
MARITIME


Caveat: Sightings record is highly subject to observer presence/opportunity
WASHINGTON
Source: BC Cetaceans Sighting Network
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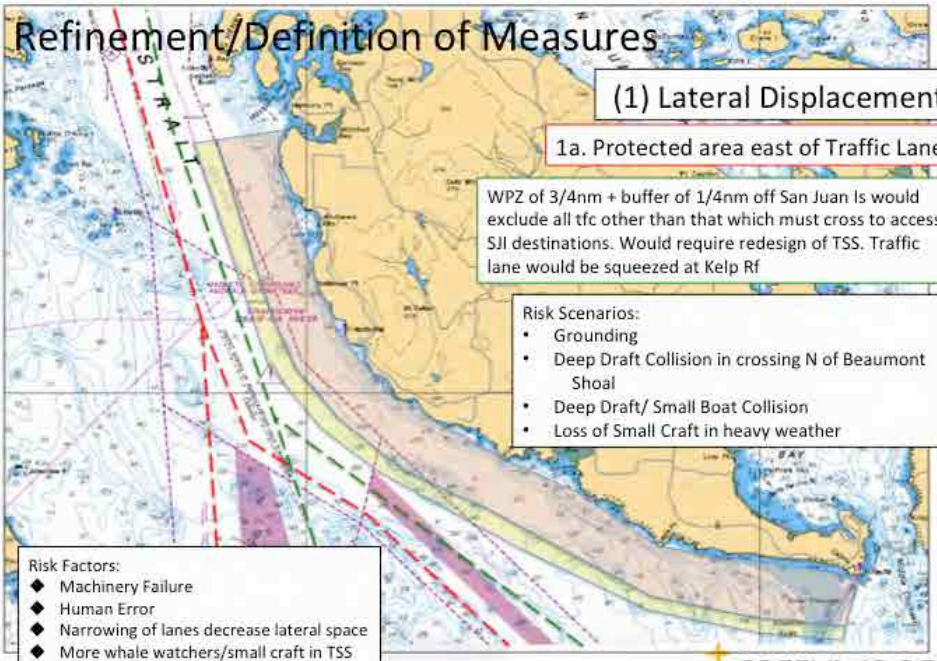
MARITIME

Refinement/Definition of Measures



(1) Lateral Displacement

1a. Protected area east of Traffic Lane

WPZ of 3/4nm + buffer of 1/4nm off San Juan Is would exclude all tfc other than that which must cross to access SJI destinations. Would require redesign of TSS. Traffic lane would be squeezed at Kelp Rf

Risk Scenarios:
- Grounding
- Deep Draft Collision in crossing N of Beaumont Shoal
- Deep Draft/ Small Boat Collision
- Loss of Small Craft in heavy weather

Risk Factors:
- Machinery Failure
- Human Error
- Narrowing of lanes decrease lateral space
- More whale watchers/small craft in TSS
- Proximity of meeting traffic at Kelp Reef
- Wx/Sea State for small craft

GREENWOOD MARITIME

Mitigations: [Measure 1A WPZ east of Traffic Lane]
- ✓ Rescue Tug [on standby]
- ✓ Enforcement of traffic lanes
- ✓ Improved Geofencing Techniques
- ✓ Dedicated VTS sector
- ✓ Smaller WPZ (less impact on TSS)
- ✓ Prevent deep draft meeting at Kelp Reef
- ✓ Securite Broadcasts
- ✓ Wx exceptions for protected area
- ✓ Education program
- ✓ Escort Tugs
- ✓ Speed Reductions

Implementation Issues:
- ✧ Getting LE presence
- ✧ Bi-national agreement
- ✧ TSS IMO approval
- ✧ Industry Consultation
- ✧ ID/Comms with small craft
- ✧ Availability/Cost of Rescue Tug
- ✧ Education of small craft operators
- ✧ Flexibility of WPZ
- ✧ Local consultation [?]

Risk Assessment Summary:

Probability:	H-4, L-1, M-2.8
Consequence:	H-5, L-3, M-3.8
Risk:	H-16, L-3, M-11.1
Mitig. Prob.	H-3, L-1, M-1.8
Mitig. Conseq.	H-5, L-3, M-3.9
Residual Risk	H-12, L-3, M-7.2
Implementation:	H-5, L-1, M-2.8

Discussion:
- ❑ Difference in Conseq due small/deep-sea impacts?
- ❑ Mitigation: Prob, Conseq, or both?
- ❑ …?

GREENWOOD MARITIME

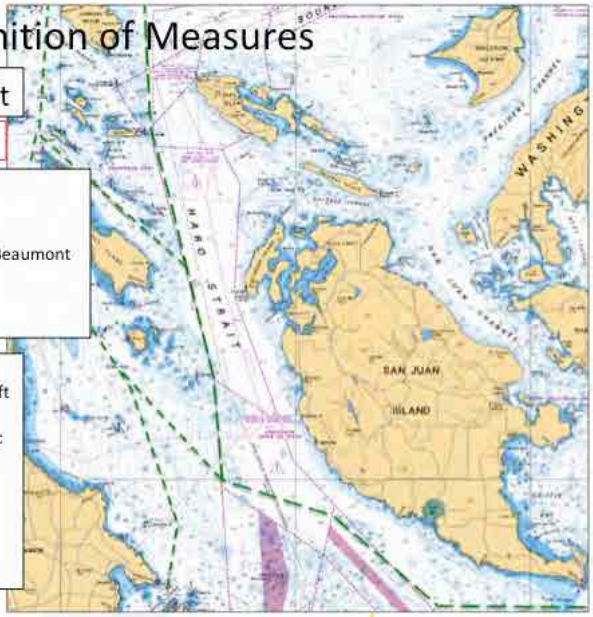
Refinement/Definition of Measures

(1) Lateral Displacement

1b. SC route west of traffic lane

Risk Scenarios:
- Deep Sea Collisions at Kelp Reef
- Groundings (especially small craft)
- Deep Draft Collision in crossing N of Beaumont
- Deep Draft/ Small Craft Collision
- Collisions between Small Craft
- Loss of tow

Risk Factors:
- Proximity of deep draft and small craft
- Crossing of small craft
- Increased small boat density of traffic
- Human Error
- Machinery Failure
- Bottom contact with tow lines
- Area too small for sailing vessels
- Reduced visibility
- Closer to shoals for small craft



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Mitigations: (Measure 1B Small craft route west of Traffic Lane)
- ✓ Better design of TSS
- ✓ Enforcement of traffic lanes
- ✓ Improved Geofencing Techniques
- ✓ Dedicated VTS sector
- ✓ Encourage small craft to cross at BS
- ✓ One-way traffic
- ✓ Only light tugs required to use route
- ✓ Require only pleasure craft and naval vessels use this measure
- ✓ Mandatory AIS carriage for small craft
- ✓ Education program
- ✓ Prohibit sailing in area
- ✓ Complete surveys and channel design process
- ✓ Provide better tide and current predictions

Implementation Issues:
- ✧ Getting LE presence
- ✧ Bi-national agreement
- ✧ TSS IMO approval
- ✧ Industry Consultation
- ✧ Regulatory change process
- ✧ Challenge of redirecting vessels when not following
- ✧ Education of small craft operators
- ✧ Noise and other issues with coastal communities

Risk Assessment Summary:

Probability:	L-2, H-4, M-2.8
Consequence:	L-2, H-5, M2.6
Risk:	L-6, H-16, M9.8
Mitig. Prob.	L-1, H-3, M1.8
Mitig. Conseq.	L-2, H5, M2.6
Residual Risk	L-3, H-12, M6.5
Implementation:	L-1, H-4, M2.7

Discussion:
- ❑
- ❑

GREENWOOD MARITIME

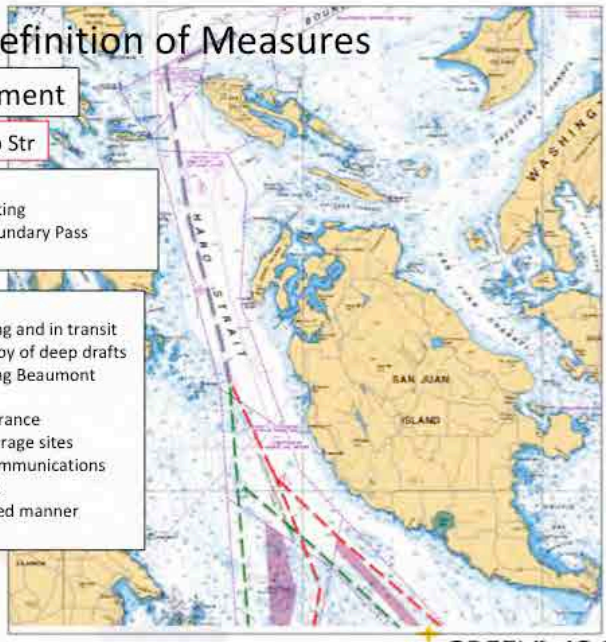
Refinement/Definition of Measures

(1) Lateral Displacement

1c. One-way traffic in Haro Str

Risk Scenarios:
- Traffic compression while waiting
- Collisions at Constance Bk, Boundary Pass
- Collisions in Haro Str

Risk Factors:
- Proximity of deep draft holding and in transit
- Crossing of small craft in convoy of deep drafts
- Crossing situations approaching Beaumont
- Machinery Failure
- Vessels loitering awaiting clearance
- Congestion at overused anchorage sites
- Language Barriers/Unclear Communications
- Closer to shoals for small craft
- Vessel navigation in unexpected manner
- Wx, Tide, Currents



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Mitigations: [Measure 1C One-way traffic in Haro]
- ✓ Better design of TSS at Beaumont
- ✓ SOA mgmt of vsls to prevent meeting at Kelp Reef
- ✓ Early notification of one-way restrictions
- ✓ Strict coordination of S & N bound vessels
- ✓ Encourage small craft to cross at BS
- ✓ Increase VTS comms about SOA and meeting situations
- ✓ Increase coord of Brotchie and VFPA terminals for SOA arrival
- ✓ Redesign TSS to reflect SOA procedures
- ✓ Tug Availability
- ✓ Require pilots for vessels loitering for clearance

Implementation Issues:
- ✧ Industry acceptance of increased pilotage time & costs
- ✧ TSS IMO approval
- ✧ Scheduling of pilotage transfers
- ✧ Warning inbound traffic to time arrivals
- ✧ Redesign of TS in a CVTS system
- ✧ Increased coordination of scheduling industry
- ✧ SOP changes and VTS staff training
- ✧ Updates to guidance in Coast Pilot, Sailing Directions, Charts, etc.

Risk Assessment Summary:

Probability:	L-1, H-5, M-2.9
Consequence:	L-3, H-5, M-4.0
Risk:	L-3, H-25, M-12.2
Mitig. Prob.	L-1, H-4, M-2.3
Mitig. Conseq.	L-3, H-5, M-3.9
Residual Risk	L-3, H-20, M-9.4
Implementation:	L-2, H-5, M-3.5

Discussion:
- ❑
- ❑

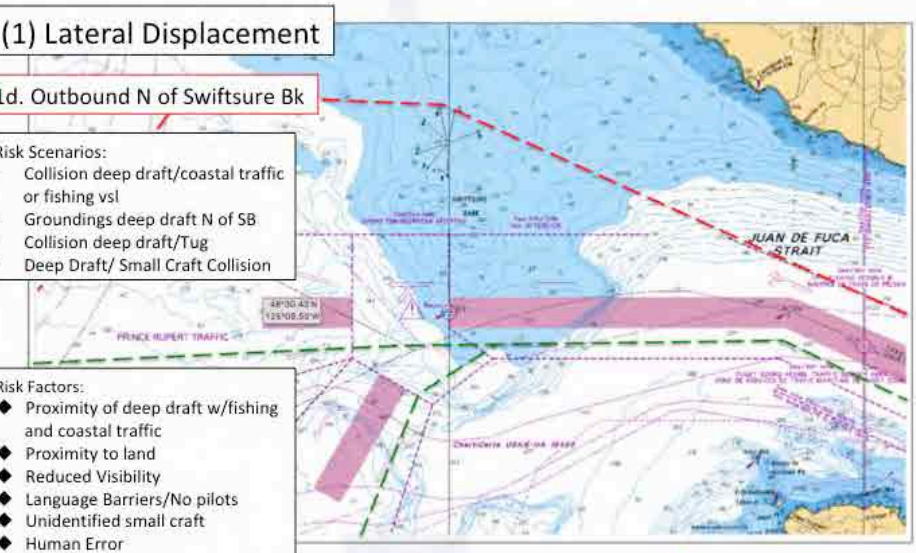
GREENWOOD MARITIME

Refinement/Definition of Measures

(1) Lateral Displacement

1d. Outbound N of Swiftsure Bk

Risk Scenarios:
- Collision deep draft/coastal traffic or fishing vsl
- Groundings deep draft N of SB
- Collision deep draft/Tug
- Deep Draft/ Small Craft Collision



Risk Factors:
- Proximity of deep draft w/fishing and coastal traffic
- Proximity to land
- Reduced Visibility
- Language Barriers/No pilots
- Unidentified small craft
- Human Error
- Mechanical Failure
- More crossing situations for exiting southbound vsls

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Mitigations: [Measure 1D Outbound lane N of SB at Buoy J]
- ✓ Extra surveillance – identifying fishing vsl locations
- ✓ Inshore traffic lanes
- ✓ Slow speed over SB
- ✓ Improved nav equipment for fishing vsls
- ✓ Expand compulsory pilotage
- ✓ Education
- ✓ Assist tug at SJDF

Implementation Issues:
- ✓ Bi-national agreement
- ✓ TSS IMO approval
- ✓ Agreement of coastal communities/ fishermen
- ✓ Getting word out of changes
- ✓ Consultation with First Nations/U.S. Tribes
- ✓ Additional monitoring
- ✓ Coordination with coastal communities
- ✓ Unintended impacts to marine life

Risk Assessment Summary:

Probability:	L-1, H-4, M-2.6
Consequence:	L-3, H-5, M-4.1
Risk:	L-3, H-20, M-11.0
Mitig. Prob.	L-1, H-3, M-2.0
Mitig. Conseq.	L-3, H-5, M-4.1
Residual Risk	L-3, H-15, M-8.2
Implementation:	L-2, H-5, M-2.8

Discussion:
- ❑
- ❑

GREENWOOD MARITIME

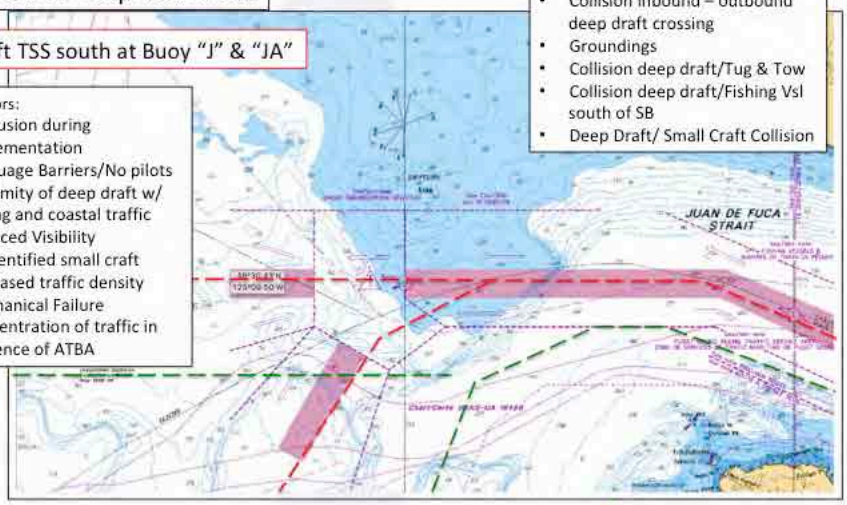
Refinement/Definition of Measures

(1) Lateral Displacement

1e. Shift TSS south at Buoy "J" & "JA"

Risk Factors:
- Confusion during implementation
- Language Barriers/No pilots
- Proximity of deep draft w/ fishing and coastal traffic
- Reduced Visibility
- Unidentified small craft
- Increased traffic density
- Mechanical Failure
- Concentration of traffic in presence of ATBA

Risk Scenarios:
- Collision inbound – outbound deep draft crossing
- Groundings
- Collision deep draft/Tug & Tow
- Collision deep draft/Fishing Vsl south of SB
- Deep Draft/ Small Craft Collision



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Mitigations: [Measure 1E Shift TSS south at Buoys J and JA]
- ✓ Notice to Shipping
- ✓ Careful tracking and Advisory by VTS
- ✓ Expand compulsory pilotage
- ✓ Extra surveillance by VTS
- ✓ Study impact to other marine life
- ✓ Provide better tide and current predictions

Implementation Issues:
- ✧ Bi-national agreement
- ✧ TSS IMO approval
- ✧ Consultation with First Nations/U.S. Tribes
- ✧ Consultation with ABTA agency
- ✧ Careful redesign of TSS
- ✧ Agreement of coastal communities/ fishermen
- ✧ Establishing additional monitoring
- ✧ Awareness of new system
- ✧ Unintended impacts to marine life

Risk Assessment Summary:

Probability:	L-1, H-3, M-2.5
Consequence:	L-1, H-5, M-3.8
Risk:	L-1, H-15, M-9.8
Mitig. Prob.	L-1, H-3, M-1.8
Mitig. Conseq.	L-1, H-5, M-3.7
Residual Risk	L-1, H-12, M-7.0
Implementation:	L-3, H-5, M-4.0

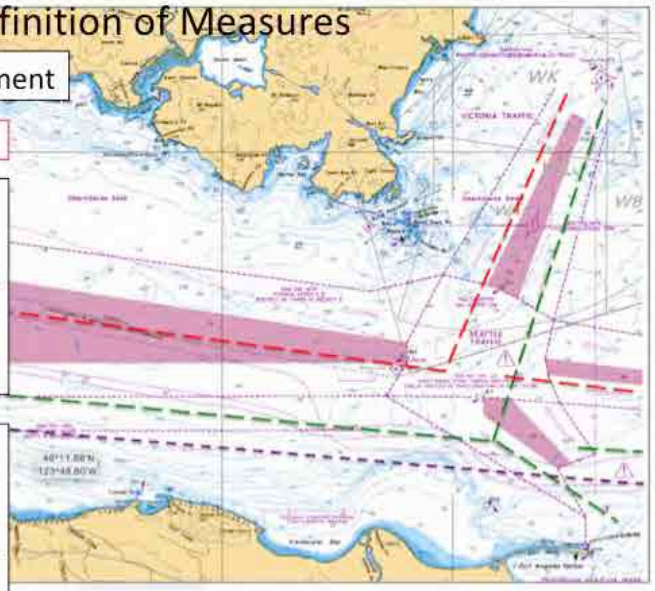
Discussion:
- ❑
- ❑

GREENWOOD MARITIME

Refinement/Definition of Measures

(1) Lateral Displacement

1f. Shift TSS south at Sooke



Risk Scenarios:
- Collision inbound – outbound deep draft crossing
- Groundings
- Collision deep draft/Tug & Tow
- Collision deep draft/Fishing Vsl south of SB
- Deep Draft/ Small Craft Collision

Risk Factors:
- Confusion during implementation
- Unidentified small craft
- Language Barriers/No pilot
- Cutting corners to make transit window
- Close Proximity to coastal traffic
- Human Error
- Vessels closer to shore in south

GREENWOOD MARITIME

Mitigations: [Measure 1F Shift TSS south at Sooke]
- ✓ Public awareness campaign
- ✓ Notice to Shipping
- ✓ VTS Advisory
- ✓ Tug Availability
- ✓ Do not change TSS at Race Rock roundabout
- ✓ Extend compulsory pilotage
- ✓ Move outbound TSS south, but decrease Separation Zone to maintain same inshore lane to south
- ✓ Discontinue Recommended 2-way route south of lanes
- ✓ Work out agreement with FN/Tribal fishing vessels to provide VTS with their location
- ✓ Contingency routing of deep drafts during FN/Tribal fishery openings

Implementation Issues:
- ✧ Bi-national agreement
- ✧ TSS IMO approval
- ✧ Consultation with FN/U.S. Tribes
- ✧ Agreement of coastal communities
- ✧ Careful redesign of TSS
- ✧ Possible Geofencing
- ✧ Additional monitoring

Risk Assessment Summary:

Probability:	L-2, H-4, M-2.8
Consequence:	L-3, H-5, M-3.9
Risk:	L-6, H-20, M-11.2
Mitig. Prob.	L-1, H-3, M-1.9
Mitig. Conseq.	L-3, H-5, M-4.0
Residual Risk	L-3, H-12, M-7.8
Implementation:	L-3, H-5, M-4.0

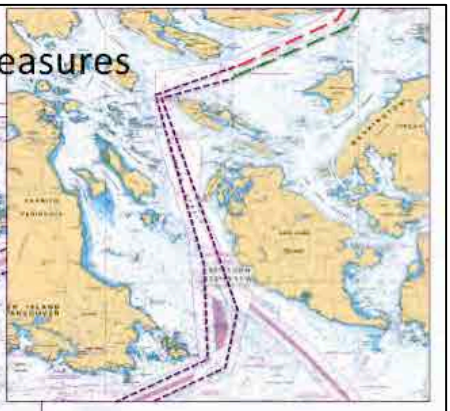
Discussion:
- ❑
- ❑

GREENWOOD MARITIME

Refinement/Definition of Measures

(2) Quiescence

2a. Quiet Periods (eg: 4hr alternating)
2b. Schedule transits (group/convoy)
2c. Manage transits (around SRKW presence)
2d. Tidal Transits (with tidal currents)



Risk Factors:
- Loitering unpredictable vessels w/crossing potential
- Increased traffic density
- Required distance between vessels not maintained
- Close proximity of traffic and overused anchorages
- Abundance of unregulated small craft
- Loitering vessels outside compulsory pilotage
- Language Barriers
- Cutting corners to make transit window
- Unexpected change of plan when SRKW detected

Risk Scenarios:
- Collision deep drafts holding at entrances to area
- Collision deep draft, small craft
- Collision deep drafts meeting in Haro Strait
- Grounding
- Allision w/vessel at anchor

GREENWOOD MARITIME

Mitigations: [Measure 2A Alt Quiet Periods]
- ✓ Time arrival at pilot station/Boundary to minimize loitering
- ✓ Keep1 nm distance separation of deep draft
- ✓ Enhance VTS monitoring
- ✓ Education of small craft operators
- ✓ Tug Availability
- ✓ Pilot Availability
- ✓ Additional mgmt. to avoid use of anchorages
- ✓ Manage arrival times at sea, not in SJDF
- ✓ Develop pilot procedure for awaiting clearance
- ✓ Require pilots on board vessels awaiting clearance
- ✓ Agreement to proceed in close proximity to other vessels at common speed

Implementation Issues:
- ✧ Bi-national agreement
- ✧ Notice to Shipping
- ✧ Consultation with PPA
- ✧ Coordination with Ports for departure times
- ✧ Pilotage availability – may need two
- ✧ Supply chain disruption
- ✧ SOP/VTS staff training
- ✧ Coast Pilot/Sailing Directions updates

Risk Assessment Summary:

Probability:	L-2, H-5, M-3.2
Consequence:	L-3, H-5, M-3.8
Risk:	L-8, H-25, M-12.2
Mitig. Prob.	L-1, H-4, M-2.1
Mitig. Conseq.	L-3, H-5, M-3.8
Residual Risk	L-3, H-20, M-8.2
Implementation:	L-2, H-5, M-2.9

Discussion:
- ❑ Very wide range of risk assessment
- ❑

GREENWOOD MARITIME

Mitigations: [Measure 2B Schedule: convoy]
- ✓ Time arrival at pilot station/Boundary to minimize loitering
- ✓ Keep1 nm distance separation of deep draft
- ✓ Enhance VTS monitoring
- ✓ Education of small craft operators
- ✓ Tug Availability
- ✓ Pilot Availability
- ✓ Additional mgmt. to avoid use of anchorages
- ✓ Manage arrival times at sea, not in SJDF
- ✓ Develop pilot procedure for awaiting clearance
- ✓ Require pilots on board vessels awaiting clearance

Implementation Issues:
- ✧ Bi-national agreement
- ✧ Notice to Shipping
- ✧ Consultation with PPA
- ✧ Coordination with Ports for departure times
- ✧ Pilotage availability – may need two
- ✧ Supply chain disruption
- ✧ SOP/VTS staff training
- ✧ Coast Pilot/Sailing Directions updates
- ✧ Grouping dissimilar ships to maintain transit group
- ✧ Industry negotiation

Risk Assessment Summary:

Probability:	L-3, H-5, M-3.6
Consequence:	L-3, H-5, M-3.9
Risk:	L-9, H-20, M-14.3
Mitig. Prob.	L-2, H-4, M-2.7
Mitig. Conseq.	L-3, H-5, M-4.0
Residual Risk	L-6, H-20, M-10.8
Implementation:	L-3, H-5, M-3.6

Discussion:
- ❑ Avg consequence higher after mitigation?
- ❑

GREENWOOD MARITIME

Mitigations: [Measure 2C Manage around SRKW]
- ✓ Allow ships to spread out at best speed after delay
- ✓ Get whale info to vessels as early as possible
- ✓ Enhance VTS monitoring
- ✓ Geofencing Techniques
- ✓ Dedicated VTS sector
- ✓ Education of small craft operators
- ✓ Tug Availability
- ✓ Pilot Availability
- ✓ Additional mgmt. to avoid use of anchorages
- ✓ Require pilots on board vessels awaiting clearance
- ✓ Deep Draft crew training

Implementation Issues:
- ✧ Negotiate process with industry
- ✧ Determine maximum wait times
- ✧ Find verifiable process for spotting SRKW – decision to suspend traffic
- ✧ Engagement with PPA
- ✧ Supply chain disruption
- ✧ Industry support
- ✧ Resource Availability needed in bunched times
- ✧ SOP/VTS staff training
- ✧ Coast Pilot/Sailing Directions updates

Risk Assessment Summary:

Probability:	L-3, H-5, M-3.7
Consequence:	L-3, H-5, M-3.9
Risk:	L-9, H-25, M-14.6
Mitig. Prob.	L-2, H-4, M-2.7
Mitig. Conseq.	L-3, H-5, M-4.0
Residual Risk	L-6, H-20, M-10.8
Implementation:	L-2, H-5, M-3.6

Discussion:
- ❑ Avg consequence higher after mitigation?
- ❑

GREENWOOD MARITIME

Mitigations: [Measure 2D Tidal transits]
- ✓ Allow ships to spread out at best speed after delay
- ✓ Enhance VTS monitoring
- ✓ Geofencing Techniques
- ✓ Dedicated VTS sector
- ✓ Education of small craft operators
- ✓ Tug Availability
- ✓ Pilot Availability
- ✓ Additional mgmt. to avoid use of anchorages
- ✓ Require pilots on board vessels awaiting clearance
- ✓ Deep Draft crew training

Implementation Issues:
- ✧ Negotiate process with industry
- ✧ Determine maximum wait times
- ✧ Find verifiable process for spotting SRKW – decision to suspend traffic
- ✧ Engagement with PPA
- ✧ Supply chain disruption
- ✧ Industry support
- ✧ Resource Availability needed in bunched times
- ✧ SOP/VTS staff training
- ✧ Coast Pilot/Sailing Directions updates

Risk Assessment Summary:

Probability:	L-2, H-5, M-2.3
Consequence:	L-3, H-5, M-3.9
Risk:	L-8, H-25, M-13.1
Mitig. Prob.	L-1, H-4, M-2.4
Mitig. Conseq.	L-3, H-5, M-3.9
Residual Risk	L-3, H-20, M-9.8
Implementation:	L-2, H-5, M-3.5

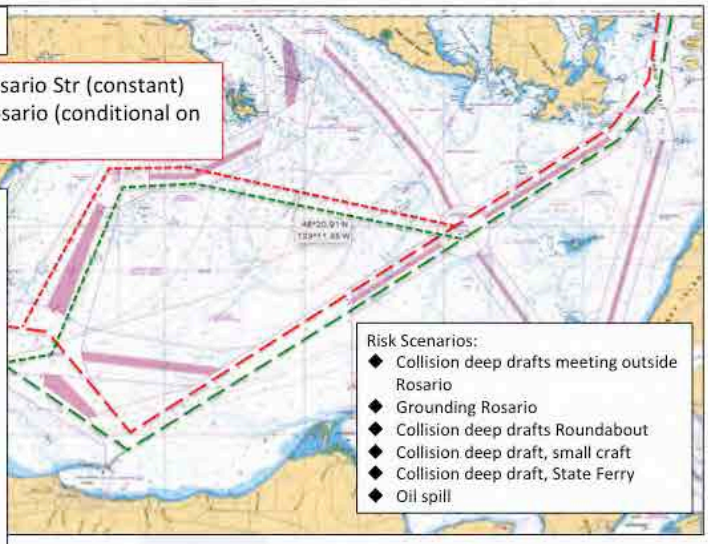
Discussion:
- ❑
- ❑

GREENWOOD MARITIME

Refinement/Definition of Measures

(3) Redirection

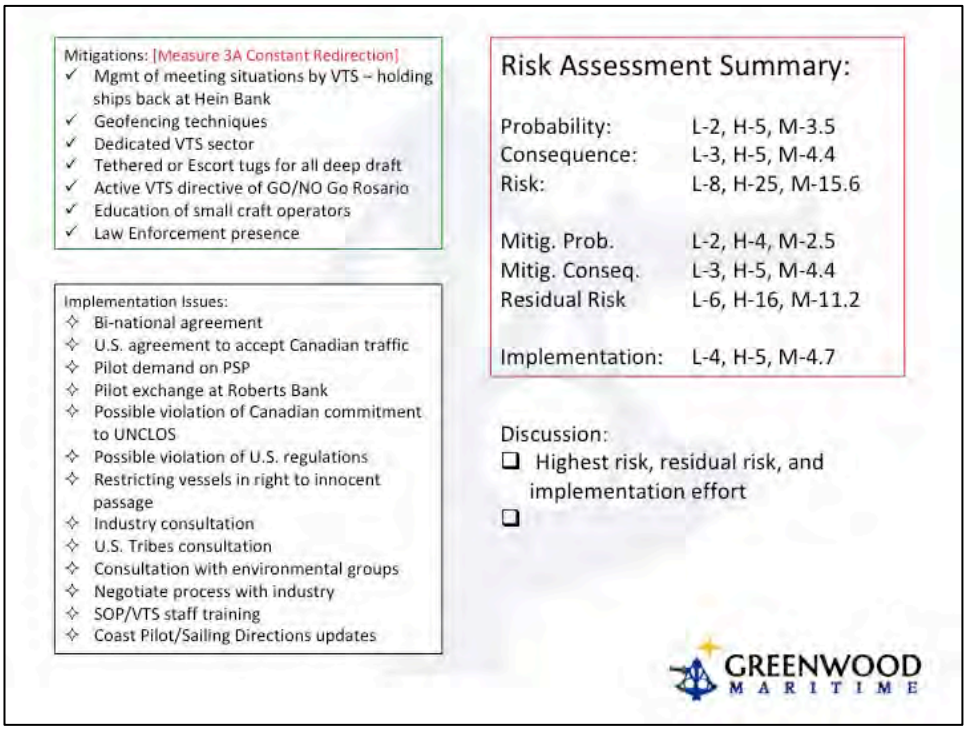
3a. Redirection to Rosario Str (constant)
3b. Redirection to Rosario (conditional on SRKW in Haro)

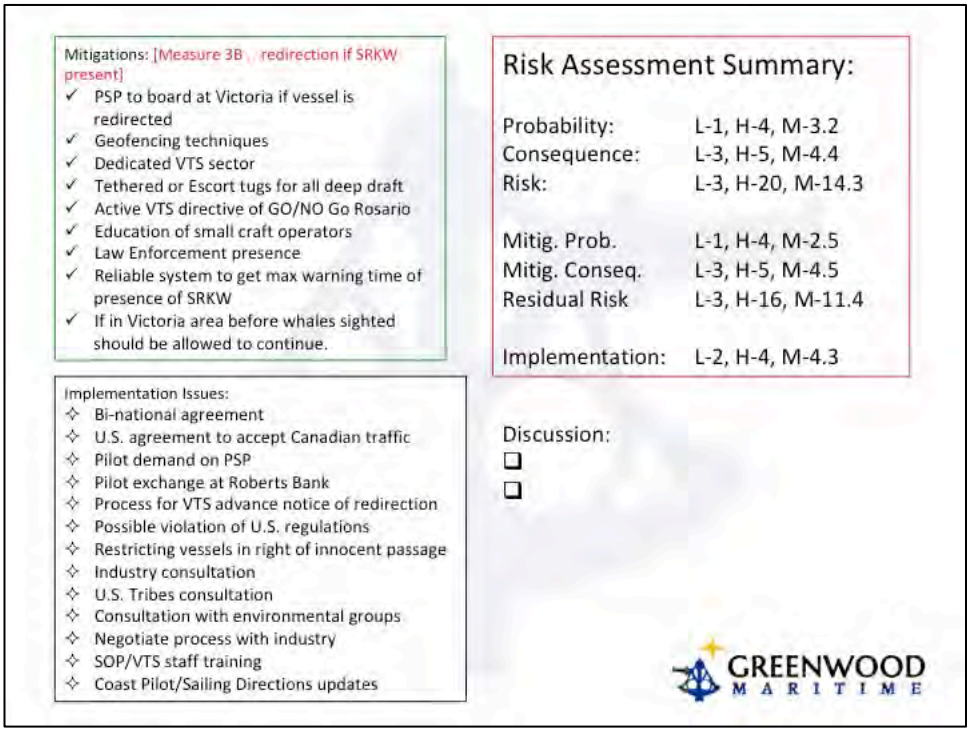


Risk Factors:
- ◆ Increase traffic density at PA pilot station/ Rosario
- ◆ Rosario more complex w/more traffic
- ◆ Confusion over redirection
- ◆ Rosario not suitable for 2-way traffic
- ◆ Proximity to land
- ◆ Abundance of unregulated small craft
- ◆ Significant potential crossing situations as part of existing scheme
- ◆ Strong currents

Risk Scenarios:
- ◆ Collision deep drafts meeting outside Rosario
- ◆ Grounding Rosario
- ◆ Collision deep drafts Roundabout
- ◆ Collision deep draft, small craft
- ◆ Collision deep draft, State Ferry
- ◆ Oil spill

GREENWOOD MARITIME

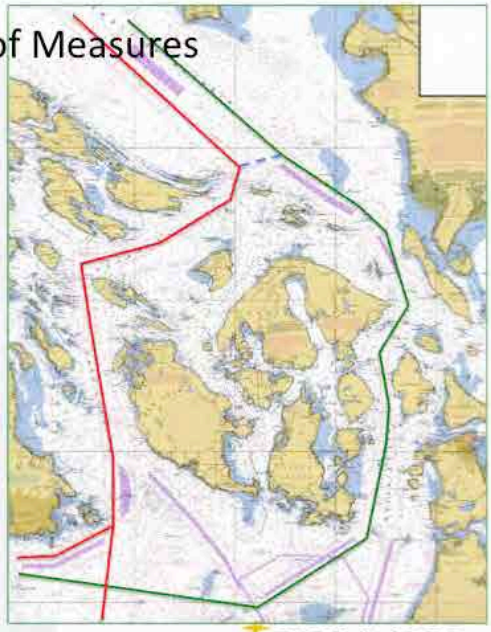

Mitigations: [Measure 3A Constant Redirection]
✓ Mgmt of meeting situations by VTS – holding ships back at Hein Bank
✓ Geofencing techniques
✓ Dedicated VTS sector
✓ Tethered or Escort tugs for all deep draft
✓ Active VTS directive of GO/NO Go Rosario
✓ Education of small craft operators
✓ Law Enforcement presence
Implementation Issues:
✧ Bi-national agreement
✧ U.S. agreement to accept Canadian traffic
✧ Pilot demand on PSP
✧ Pilot exchange at Roberts Bank
✧ Possible violation of Canadian commitment to UNCLOS
✧ Possible violation of U.S. regulations
✧ Restricting vessels in right to innocent passage
✧ Industry consultation
✧ U.S. Tribes consultation
✧ Consultation with environmental groups
✧ Negotiate process with industry
✧ SOP/VTS staff training
✧ Coast Pilot/Sailing Directions updates
Risk Assessment Summary:
Probability: L-2, H-5, M-3.5
Consequence: L-3, H-5, M-4.4
Risk: L-8, H-25, M-15.6
Mitig. Prob. L-2, H-4, M-2.5
Mitig. Conseq. L-3, H-5, M-4.4
Residual Risk L-6, H-16, M-11.2
Implementation: L-4, H-5, M-4.7
Discussion:
❑ Highest risk, residual risk, and implementation effort
❑
GREENWOOD MARITIME


Mitigations: [Measure 3B , redirection if SRKW present]
✓ PSP to board at Victoria if vessel is redirected
✓ Geofencing techniques
✓ Dedicated VTS sector
✓ Tethered or Escort tugs for all deep draft
✓ Active VTS directive of GO/NO Go Rosario
✓ Education of small craft operators
✓ Law Enforcement presence
✓ Reliable system to get max warning time of presence of SRKW
✓ If in Victoria area before whales sighted should be allowed to continue.
Implementation Issues:
✧ Bi-national agreement
✧ U.S. agreement to accept Canadian traffic
✧ Pilot demand on PSP
✧ Pilot exchange at Roberts Bank
✧ Process for VTS advance notice of redirection
✧ Possible violation of U.S. regulations
✧ Restricting vessels in right of innocent passage
✧ Industry consultation
✧ U.S. Tribes consultation
✧ Consultation with environmental groups
✧ Negotiate process with industry
✧ SOP/VTS staff training
✧ Coast Pilot/Sailing Directions updates
Risk Assessment Summary:
Probability: L-1, H-4, M-3.2
Consequence: L-3, H-5, M-4.4
Risk: L-3, H-20, M-14.3
Mitig. Prob. L-1, H-4, M-2.5
Mitig. Conseq. L-3, H-5, M-4.5
Residual Risk L-3, H-16, M-11.4
Implementation: L-2, H-4, M-4.3
Discussion:
❑
❑
GREENWOOD MARITIME

Refinement/Definition of Measures

(3) Redirection

3c. One way traffic CCW Rosario-Haro



Risk Scenarios:
- Collision deep drafts N of Patos Island
- Collision deep drafts crossing traffic West of New Dungeness
- Grounding Rosario/ Alden Bank
- Grounding Haro
- Collision deep draft, small craft
- Collision deep draft, State Ferry
- Oil spill

Risk Factors:
- Increase traffic density Rosario
- Increase tanker traffic in Rosario
- Increased crossing traffic at Patos
- Increased crossing traffic from Discovery Isl to PA pilot station
- Proximity to land
- Confusion over redirection
- Abundance of unregulated small craft
- Vessel separation requirements with a ferry crossing will be difficult with increased traffic
- Strong currents

GREENWOOD MARITIME

Mitigations: [Measure 3C One Way CCW Rosario-Haro]
- ✓ Geofencing techniques
- ✓ Dedicated VTS sector
- ✓ Tethered or Escort tugs for all deep draft
- ✓ Education of small craft operators
- ✓ Law Enforcement presence

Implementation Issues:
- ✧ Bi-national agreement
- ✧ U.S. agreement to accept Canadian traffic
- ✧ Pilot demand on PSP
- ✧ Pilot exchange at Roberts Bank
- ✧ Possible violation of Canadian commitment to UNCLOS
- ✧ Possible violation of U.S. regulations
- ✧ Industry consultation
- ✧ U.S. Tribes consultation
- ✧ Consultation with environmental groups
- ✧ SOP/VTS staff training
- ✧ Coast Pilot/Sailing Directions updates

Risk Assessment Summary:

Probability:	L-1, H-4, M-2.8
Consequence:	L-3, H-5, M-4.4
Risk:	L-3, H-20, M-12.9
Mitig. Prob.	L-1, H-4, M-2.3
Mitig. Conseq.	L-3, H-5, M-4.4
Residual Risk	L-3, H-16, M-10.2
Implementation:	L-2, H-5, M-4.3

Discussion:
- ❑
- ❑

GREENWOOD MARITIME

Refinement/Definition of Measures

(4) Speed Reduction

4a. Fixed Speed Reduction
4b. Circumstantial Sp Reduction
4c. Conditional (by Ship) Sp Reduction
4d. Circumstantial Sp Reduction in SJDF

Risk Factors:
- Limitation of ship control at slow speed in strong current
- Proximity to land
- Abundance of unregulated small craft
- Significant potential crossing situations
- Additional risk for some vessels restricted in maneuvering and alterations due to speed.
- Increase fatigue for pilot/crew
- Loss of situational awareness due to fatigue
- Human error
- Mechanical Failure
- Traffic congestion
- Inability to match speed – challenge maintaining safe CPA due to environmentals and vsl draft
- Extreme wx
- Commercial pressure

Risk Scenarios:
- Collision deep drafts in Haro
- Grounding in Haro
- Hard strike at berth making up time
- Collision deep drafts in Haro
- Grounding in Haro
- Collision [in Haro] due to awkward overtaking situations
- Collision/Grounding in SJDF

Mitigations: [Measure 4A Fixed Max Sp in Haro]
- ✓ Do not require speed of less than 10kts
- ✓ Mandatory double pilots
- ✓ Allow exceptions for safety situations
- ✓ Use Rosario

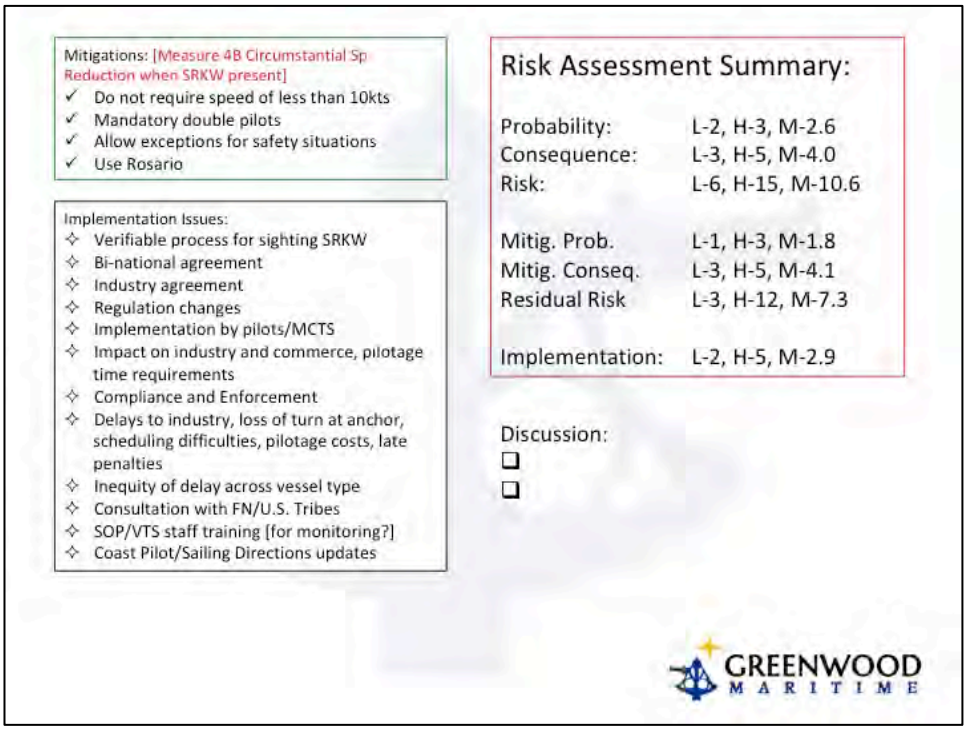
Implementation Issues:
- ✧ Bi-national agreement
- ✧ Industry agreement
- ✧ Regulation changes
- ✧ Implementation by pilots/MCTS
- ✧ Impact on industry and commerce, pilotage time requirements
- ✧ Compliance and Enforcement
- ✧ Delays to industry, loss of turn at anchor, scheduling difficulties, pilotage costs, late penalties
- ✧ If no whales, why slow down
- ✧ Inequity of delay across vessel type
- ✧ Consultation with FN/U.S. Tribes
- ✧ SOP/VTS staff training [for monitoring?]
- ✧ Coast Pilot/Sailing Directions updates

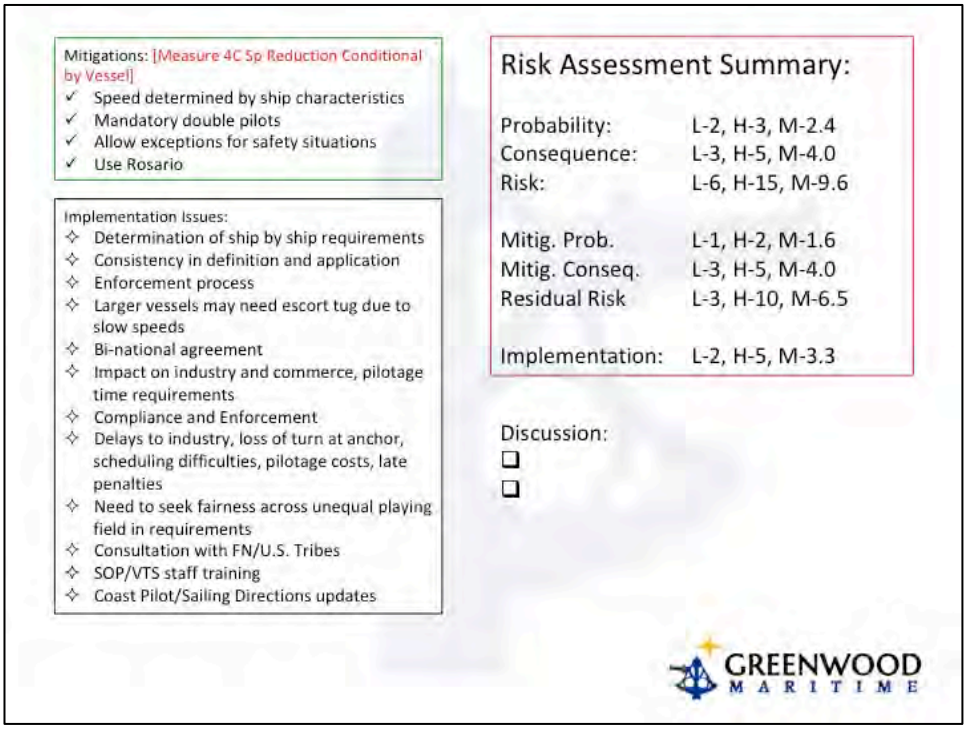
Risk Assessment Summary:

Probability:	L-2, H-3, M-2.5
Consequence:	L-3, H-5, M-4.0
Risk:	L-6, H-15, M-10.3
Mitig. Prob.	L-1, H-2, M-1.6
Mitig. Conseq.	L-3, H-4, M-4.0
Residual Risk	L-3, H-10, M-6.5
Implementation:	L-1, H-5, M-2.7

Discussion:
- ❑
- ❑

GREENWOOD MARITIME


Mitigations: [Measure 4B Circumstantial Sp Reduction when SRKW present]
✓ Do not require speed of less than 10kts
✓ Mandatory double pilots
✓ Allow exceptions for safety situations
✓ Use Rosario
Implementation Issues:
✧ Verifiable process for sighting SRKW
✧ Bi-national agreement
✧ Industry agreement
✧ Regulation changes
✧ Implementation by pilots/MCTS
✧ Impact on industry and commerce, pilotage time requirements
✧ Compliance and Enforcement
✧ Delays to industry, loss of turn at anchor, scheduling difficulties, pilotage costs, late penalties
✧ Inequity of delay across vessel type
✧ Consultation with FN/U.S. Tribes
✧ SOP/VTS staff training [for monitoring?]
✧ Coast Pilot/Sailing Directions updates
Risk Assessment Summary:
Probability: L-2, H-3, M-2.6
Consequence: L-3, H-5, M-4.0
Risk: L-6, H-15, M-10.6
Mitig. Prob. L-1, H-3, M-1.8
Mitig. Conseq. L-3, H-5, M-4.1
Residual Risk L-3, H-12, M-7.3
Implementation: L-2, H-5, M-2.9
Discussion:
❑
❑
GREENWOOD MARITIME


Mitigations: [Measure 4C Sp Reduction Conditional by Vessel]
✓ Speed determined by ship characteristics
✓ Mandatory double pilots
✓ Allow exceptions for safety situations
✓ Use Rosario
Implementation Issues:
✧ Determination of ship by ship requirements
✧ Consistency in definition and application
✧ Enforcement process
✧ Larger vessels may need escort tug due to slow speeds
✧ Bi-national agreement
✧ Impact on industry and commerce, pilotage time requirements
✧ Compliance and Enforcement
✧ Delays to industry, loss of turn at anchor, scheduling difficulties, pilotage costs, late penalties
✧ Need to seek fairness across unequal playing field in requirements
✧ Consultation with FN/U.S. Tribes
✧ SOP/VTS staff training
✧ Coast Pilot/Sailing Directions updates
Risk Assessment Summary:
Probability: L-2, H-3, M-2.4
Consequence: L-3, H-5, M-4.0
Risk: L-6, H-15, M-9.6
Mitig. Prob. L-1, H-2, M-1.6
Mitig. Conseq. L-3, H-5, M-4.0
Residual Risk L-3, H-10, M-6.5
Implementation: L-2, H-5, M-3.3
Discussion:
❑
❑
GREENWOOD MARITIME

Mitigations: [Measure 4D Sp Reduction in SJDF with SRKW presence]

- ✓ Do not require speed of less than 10kts
- ✓ VTS to provide locations of fishing vessels to deep draft
- ✓ Expand compulsory pilotage
- ✓ Allow exceptions for safety situations

Implementation Issues:

- ✧ Definition of areas
- ✧ Look-out or notification of SRKW
- ✧ Method of detecting if SRKW present
- ✧ Bi-national agreement
- ✧ Awareness of new system to foreign vessels
- ✧ Geofencing techniques
- ✧ Compliance and Enforcement
- ✧ SOP/VTS staff training [for monitoring?]
- ✧ Coast Pilot/Sailing Directions updates

Risk Assessment Summary:

Probability:	L-1, H-5, M-2.5
Consequence:	L-2, H-5, M-3.8
Risk:	L-2, H-20, M-10.3
Mitig. Prob.	L-1, H-5, M-2.1
Mitig. Conseq.	L-2, H-5, M-2.8
Residual Risk	L-2, H-20, M-8.3
Implementation:	L-2, H-5, M-3.0

Discussion:

- ❑ Very wide variance in risk assessment
- ❑

GREENWOOD MARITIME

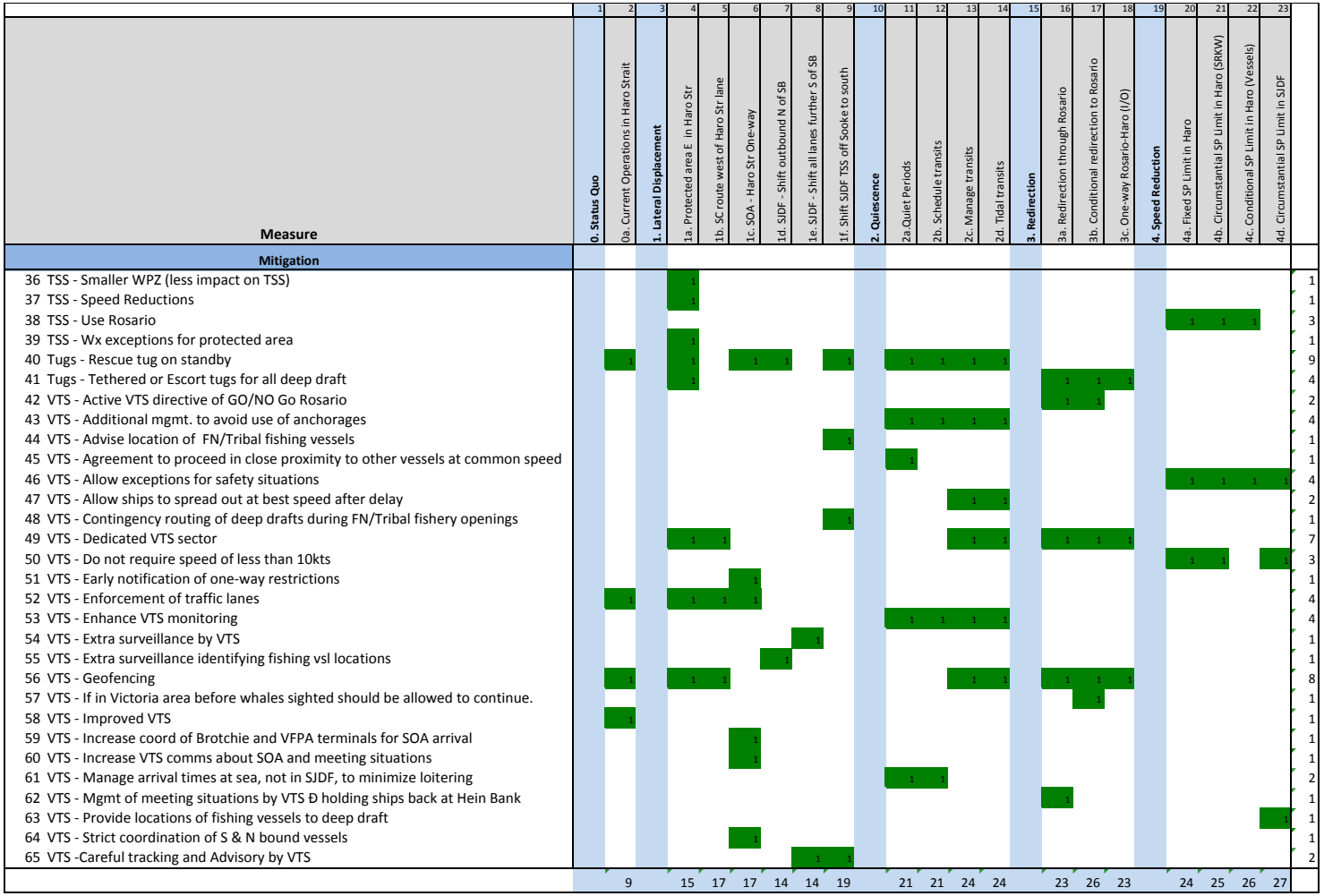
Other Concerns?

- ➢ What have we missed and need to include within this Risk Assessment?

GREENWOOD MARITIME

ANNEX C. RA MITIGATIONS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Measure	**0. Status Quo**	0a. Current Operations in Haro Strait	**1. Lateral Displacement**	1a. Protected area E. in Haro Str	1b. SC route west of Haro Str lane	1c. SOA - Haro Str One-way	1d. SJDF - Shift outbound N of SB	1e. SJDF - Shift all lanes further S of SB	1f. Shift SJDF TSS off Sooke to south	**2. Quiescence**	2a.Quiet Periods	2b. Schedule transits	2c. Manage transits	2d. Tidal transits	**3. Redirection**	3a. Redirection through Rosario	3b. Conditional redirection to Rosario	3c. One-way Rosario-Haro (I/O)	**4. Speed Reduction**	4a. Fixed SP Limit in Haro	4b. Circumstantial SP Limit in Haro (SRKW)	4c. Conditional SP Limit in Haro (Vessels)	4d. Circumstantial SP Limit in SJDF	
Mitigation																								
1 CCG - Law Enforcement presence		1														1	1	1						4
2 CCG - Notice to Shipping								1	1															2
3 DFO - Provide better tide and current prediction					1			1																2
4 DFO - Reliable system to get max warning time of presence of SRKW													1				1							2
5 DFO - Study impact to other marine life								1																1
6 Education - general		1		1	1		1																	4
7 Education - Encourage small craft to cross at BS					1	1																		2
8 Education - Public awareness campaign									1															1
9 Education - Small craft operators											1	1	1	1		1	1	1						7
10 Education -Deep Draft crew training													1	1										2
11 Pilots - Develop pilot procedure for awaiting clearance											1	1												2
12 Pilots - Expand compulsory pilotage							1	1	1														1	4
13 Pilots - Keep 1 nm distance separation of deep draft											1	1												2
14 Pilots - Mandatory double pilots																				1	1	1		3
15 Pilots - Pilot Availability (i.e. scheduling)											1	1	1	1										4
16 Pilots - Prevent deep draft meeting at Kelp Reef				1																				1
17 Pilots - Puget Sound Pilots to board at Victoria if vessel is redirected																	1							1
18 Pilots - Require pilots for vessels loitering for clearance						1					1	1	1	1										5
19 Pilots - Securite Broadcasts				1																				1
20 Pilots - SOA mgmt of vsls to prevent meeting at Kelp Reef						1																		1
21 TC - Improved nav equipment for fishing vsls							1																	1
22 TC - Mandatory AIS carriage for small craft					1																			1
23 TC - Speed determined by ship characteristics																						1		1
24 TSS - Better design of TSS					1	1																		2
25 TSS - Complete surveys and channel design process					1																			1
26 TSS - Discontinue Recommended 2-way route south of lanes									1															1
27 TSS - Do not change TSS at Race Rock roundabout									1															1
28 TSS - Inshore traffic lanes							1																	1
29 TSS - Move outbound TSS south, but decrease Separation Zone									1															1
30 TSS - One-way traffic					1																			1
31 TSS - Prohibit sailing in area					1																			1
32 TSS - Redesign TSS to reflect SOA procedures						1																		1
33 TSS - Require only pleasure craft, naval vessels, light tugs					1																			1
34 TSS - Separation of SC		1																						1
35 TSS - Slow speed over SB							1																	1


Measure
0. Status Quo
0a. Current Operations in Haro Strait
1. Lateral Displacement
1a. Protected area E in Haro Str
1b. SC route west of Haro Str lane
1c. SOA - Haro Str One-way
1d. SJDF - Shift outbound N of SB
1e. SJDF - Shift all lanes further S of SB
1f. Shift SJDF TSS off Sooke to south
2. Quiescence
2a Quiet Periods
2b. Schedule transits
2c. Manage transits
2d. Tidal transits
3. Redirection
3a. Redirection through Rosario
3b. Conditional redirection to Rosario
3c. One-way Rosario-Haro (I/O)
4. Speed Reduction
4a. Fixed SP Limit in Haro
4b. Circumstantial SP Limit in Haro (SRKW)
4c. Conditional SP Limit in Haro (Vessels)
4d. Circumstantial SP Limit in SJDF
Mitigation
36 TSS - Smaller WPZ (less impact on TSS)
37 TSS - Speed Reductions
38 TSS - Use Rosario
39 TSS - Wx exceptions for protected area
40 Tugs - Rescue tug on standby
41 Tugs - Tethered or Escort tugs for all deep draft
42 VTS - Active VTS directive of GO/NO Go Rosario
43 VTS - Additional mgmt. to avoid use of anchorages
44 VTS - Advise location of FN/Tribal fishing vessels
45 VTS - Agreement to proceed in close proximity to other vessels at common speed
46 VTS - Allow exceptions for safety situations
47 VTS - Allow ships to spread out at best speed after delay
48 VTS - Contingency routing of deep drafts during FN/Tribal fishery openings
49 VTS - Dedicated VTS sector
50 VTS - Do not require speed of less than 10kts
51 VTS - Early notification of one-way restrictions
52 VTS - Enforcement of traffic lanes
53 VTS - Enhance VTS monitoring
54 VTS - Extra surveillance by VTS
55 VTS - Extra surveillance identifying fishing vsl locations
56 VTS - Geofencing
57 VTS - If in Victoria area before whales sighted should be allowed to continue.
58 VTS - Improved VTS
59 VTS - Increase coord of Brotchie and VFPA terminals for SOA arrival
60 VTS - Increase VTS comms about SOA and meeting situations
61 VTS - Manage arrival times at sea, not in SJDF, to minimize loitering
62 VTS - Mgmt of meeting situations by VTS Ð holding ships back at Hein Bank
63 VTS - Provide locations of fishing vessels to deep draft
64 VTS - Strict coordination of S & N bound vessels
65 VTS -Careful tracking and Advisory by VTS
9 15 17 17 14 14 19 21 21 24 24 23 26 23 24 25 26 27

ANNEX D. IMPLEMENTATION ISSUES