Protecting Blue Whales and Blue Skies VSR Program

Air Emission Reduction Methodology & Results

2024 Season

Blue Whales Blue Skies

Background

The Protecting Blue Whales and Blue Skies (BWBS) Vessel Speed Reduction (VSR) Program began as a trial in 2014 and it has been growing with each successful iteration. For the first few years of the program, containerships and auto carriers were invited to participate if the historic, baseline speed of the specific vessel within the Santa Barbara Channel or San Francisco Bay Area zones was high (e.g. 14 knots or greater). At that time, limited funds were available for financial incentives, and so the focus of the program was on reducing the speed of the fastest ships in the region based on transit-specific data for the prior years.

However, with the expansion of the 2018 VSR season to include all vessel activities under an enrolled company, the time intensive process of determining emission reductions based on the historic, transit-specific speeds of each vessel was no longer practical. Furthermore, companies were introducing new vessels and new routes to California which didn't have transit-specific baseline speeds. Hence, this document outlines the updated, fleet-based methodology, which accounts for the normal operating speed of all vessels within a ship sector using the 2016 and 2017 baseline speeds. Emission reductions are then calculated for each season by looking at the difference in emissions between the participating vessels at their estimated baseline speed and the actual emissions at their VSR-compliant speeds.

A summary table of the various program expansions is shown below which demonstrates the VSR request durations, the applicable vessels that have been invited to participate, and the additional zones that have been added to the program.

Table 1: Summary of BWBS VSR Expansions

<table>
<tr><th>VSR Season</th><th>Duration</th><th>Basis</th><th>Speed Target</th><th>Vessel Applicability</th><th>Zones</th></tr>
<tr><td>2014</td><td>4 months</td><td rowspan="2">Transit</td><td>12 knots</td><td rowspan="8">Containerships & Auto Carriers</td><td>Santa Barbara (SB) Channel</td></tr>
<tr><td>2016</td><td rowspan="2">4.5 months</td><td rowspan="2">10-12 knots</td><td>Add south of Channel Islands</td></tr>
<tr><td>2017</td><td>Add San Francisco (SF) lanes</td></tr>
<tr><td>2018</td><td rowspan="7">Fleet</td><td rowspan="8">10 knots</td><td>---</td></tr>
<tr><td>2019</td><td rowspan="3">6 months</td><td>---</td></tr>
<tr><td>2020</td><td>Add POLA/POLB zones</td></tr>
<tr><td>2021</td><td>---</td></tr>
<tr><td>2022</td><td rowspan="2">7.5 months</td><td>Add Bulk & General Cargo</td><td>Add Greater Farallones & Cordell Bank NMS (SF zones)</td></tr>
<tr><td>2023</td><td>Add Tankers</td><td>Add Monterey Bay NMS</td></tr>
<tr><td>2024</td><td>8 months</td><td>---</td><td>---</td></tr>
</table>

Baseline (Non-VSR) Speed Datasets

For the Santa Barbara Channel and San Francisco Bay Area regions, AIS (Automatic Identification System) data was obtained for all vessel activities within each zone for calendar years 2016 and 2017. Vessel activities within the months of May through November were removed to prevent any bias from the previous 2016 and 2017 BWBS VSR seasons and from the NOAA requests for all vessels 300 gross tons or larger to slow down to 10 knots or less.

In 2020, the BWBS program expanded to include the Port of Los Angeles (POLA) and Port of Long Beach (POLB) 40 nautical mile VSR zone in Southern California. Permission was obtained to analyze the 2016 and 2017 calendar year Southern California Marine Exchange AIS vessel speed data to help establish BWBS baseline speeds in these zones. Since these ports have existing VSR programs to slow down to 12 knots or less and the programs have been in effect year-round since 2001 with a high level of cooperation, no months were excluded from the baseline speed calculations for the port zone.

In 2022 and 2023, the BWBS program expanded to include the three National Marine Sanctuaries in the San Francisco Bay Area. For these zones, a similar AIS analysis was performed using 2017 calendar year data. Data in the months of May through November were removed for the Cordell Bank and Greater Farallones NMS to prevent any bias from the NOAA requests to slow down to 10 knots or less. The Monterey Bay NMS did not participate in the NOAA requests in 2017, and so no data was excluded from the analysis for the MBNMS zone.

Speed Correction Factors (SCFs)

Each dataset was used to estimate average speed correction factors of each vessel type in each zone, with containerships further classified by TEU (Twenty-foot Equivalent Unit) capacity. Using the IHS database (formerly known as Lloyd's Registry), each vessel had its engine and operating specifications reviewed to determine its maximum rated speed. Table 2 below provides a summary of the average maximum rated speeds for each vessel type.

Table 2: Average Maximum Rated Speed, by Vessel Type

Vessel Type	Vessel Size	Avg. Max Rated Speed *(knots)*
Auto & RoRo	All	19.8
Containership (small)	1,000 - 5,000 TEU	22.5
Containership (medium)	6,000 - 9,000 TEU	24.8
Containership (large)	10,000+ TEU	24.1
Bulk	All	15.0
General Cargo	All	16.0
Tanker	All	15.0

Speed Correction Factors are then calculated for each vessel type in each VSR zone to address the different operating speeds in each zone. SCFs were calculated for all ships in the 2016 and 2017 data sets based on Equation 1 below, and these SCFs were then averaged together. The calculated SCFs for each vessel type for the BWBS VSR zones are presented below in Tables 3 and 4, and the corresponding maps to demonstrate the zone boundaries are included in Appendices A and B at the end of this document.

Equation 1: Establishing SCFs, by Vessel

$$(SCF)_{\text{vessel-zone}} = \frac{(\text{Non-VSR speed})_{\text{vessel-zone, in knots}}}{(\text{Maximum rated speed})_{\text{vessel, in knots}}}$$

Table 3: Southern California Average SCFs, by Vessel Type

Vessel Type	VSR Zone			
	Santa Barbara Channel	POLA/POLB IMO Lane Arrival	POLA/POLB Departure & Inside 40 nm	South of Channel Islands & Remaining Outside 40 nm
Auto & RoRo	0.66	0.47	0.53	0.73
Containership (small)	0.63	0.47	0.50	0.69
Containership (medium)	0.62	0.43	0.47	0.59
Containership (large)	0.58	0.42	0.46	0.63
Bulk	0.82	0.73	0.75	0.82
General Cargo	0.76	0.70	0.74	0.80
Tanker	0.80	0.70	0.74	0.75

Table 4: Bay Area and Monterey Bay Average SCFs, by Vessel Type

Vessel Type	VSR Zone		
	SF IMO Lane Arrival	SF IMO Lane Departure	Marine Sanctuaries (non-Lane)
Auto & RoRo	0.57	0.77	0.73
Containership (small)	0.57	0.70	0.63
Containership (medium)	0.52	0.62	0.60
Containership (large)	0.52	0.62	0.59
Bulk	0.71	0.81	0.78
General Cargo	0.66	0.79	0.78
Tanker	0.71	0.75	0.79

Additional parameters for determining the zones and how they were analyzed are listed below:

- In the San Francisco Bay Area and POLA/POLB IMO-designated lanes, SCFs were analyzed based on trip direction (arrival vs. departure) since vessels in these zones tend to travel at higher speeds after departing from the nearby port (compared to the arrival leg).
- SCFs within the POLA/POLB 40 nautical mile VSR zone were averaged for the entire Northern route, while SCFs for the Southern route were averaged out to 25 nautical miles to stay consistent with the boundaries of the BWBS VSR Program.
- Due to the lack of IMO-approved shipping lanes for the POLA/POLB Western route, no adjustments were made to account for differences between inbound and outbound speeds on this route. All speed data for the Western route was comparable to and incorporated into the POLA/POLB departure routes.

- The Santa Barbara Channel and remaining VSR zones outside the POLA/POLB 40 nautical mile radius are in open water and cover a greater distance, so vessel speeds have not been observed to correlate to transit direction to nearby ports.
- Note that there are some smaller areas, such as the SF Precautionary Area and the POLA/POLB Precautionary Area, in which the program records cooperation with the slow-speed requests, but speed correction factors and emission calculations are not performed because the BWBS program most likely did not change ship behavior in these zones.
- For the ATBAs (Areas To Be Avoided) in Southern California, no emission reductions are calculated because the program requests the vessels to avoid these areas.
- In 2023, vessels were requested to prioritize use of the Western IMO-designated lane of the San Francisco TSS (Traffic Separation Scheme). Due to this request and other routing behavior changes since 2017, the SCFs for the Northern, Western, and Southern IMO-designated lanes for the Bay Area were averaged together.

Emission Reduction Calculations

For each enrolled fleet that complies with the program parameters, the program estimates the baseline speed for each participating vessel in each zone using the SCFs defined in the previous section. The baseline speeds are calculated using the following equation:

Equation 2: Determining Vessel Baseline Speeds

$$(\text{Baseline Speed})_{\text{vessel-zone}} = (\text{Max Rated Speed})_{\text{vessel}} * (\text{SCF})_{\text{avg vessel-zone}}$$

The emissions for each participating vessel are then calculated at both the baseline speed and at the observed VSR speed for each zone that it passes through on its transit. Vessels often travel through multiple zones, and so an example is provided in Table 5 below to demonstrate the various baseline and observed speeds for an entire trip through the region.

Table 5: Example SCFs and Speeds for the MSC Eleni
[IMO #9278143; Small Containership with a Max Rated Speed of 24.3 knots]

Transit Date	Zone	SCF	Baseline Speed	Observed Transit Speed	Observed Transit Distance
8/4/2024	SB Channel	0.63	15.3 knots	9.8 knots	97.3 nm
8/4/2024	POLA Arrival	0.47	11.4 knots	9.4 knots	41.9 nm
8/5/2024	POLA Departure	0.50	12.1 knots	9.7 knots	42.0 nm
8/5/2024	SB Channel	0.63	15.3 knots	9.7 knots	97.1 nm

Since the AIS data for the VSR analysis is consolidated into segments, all segments with an observed distance-weighted speed of 12 knots or less will be attributed to the program calculations to account for any short-term vessel maneuvers that slightly exceeded the 10-knot target. Any activity from vessels that slowed down from their baseline speed – but did not achieve 12 knots – were excluded as these instances were most likely influenced by other factors

outside the VSR program. Additionally, segments where a vessel has been observed to be at anchor or loitering in a VSR zone have been removed.

Emission calculations are performed for Oxides of Nitrogen (NOx), Oxides of Sulfur (SOx), Diesel Particulate Matter (DPM), and Greenhouse Gases (GHGs - as carbon dioxide equivalent (CO_2E)). All emission calculations are performed by Starcrest Consulting using the same emission factors and adjustments used for the POLA/POLB emission inventory. For more information on the POLA/POLB emission inventory, please visit: www.portoflosangeles.org/environment/air-quality/air-emissions-inventory.

Alternative Fuels and Low-Load Factors

For the 2024 season, approximately 4% of the participating vessels were equipped with dual-fuel engines, meaning that they were capable of using alternative fuels such as Liquefied Natural Gas (LNG) or methanol. However, at this time, all vessels are assumed to be combusting conventional, low-sulfur marine diesel fuel in the VSR zones. Additional data collection and analysis is being performed by Starcrest Consulting to refine the dual-fuel usage parameters for future VSR seasons.

As of December 2024, the California Air Resources Board has published a draft update to their Ocean-Going Vessel (OGV) emission calculation methodology that incorporated new low-load factors for the main propulsion engines. These draft low-load factors have not been incorporated into the 2024 VSR calculations. Additional tracking and analysis of the updates to the low-load factors will be performed for future VSR seasons.

Emission Reduction Results - 2024 VSR Season

As shown in Table 6 below, the Blue Whales and Blue Skies VSR Program resulted in an estimated reduction of 1,405 tons of NOx, 33 tons of SOx, 8.4 tons of DPM, and 49,945 metric tons of Greenhouse Gases during the 2024 season. Compared to baseline conditions, these reductions signify a 27% decrease in NOx, SOx, and GHG emissions and a 20% decrease in DPM. The 2024 season results are also broken down by ship type and by region to show their relative contributions.

Table 6: 2024 VSR Season Results – Total, By Ship Type, and By Region

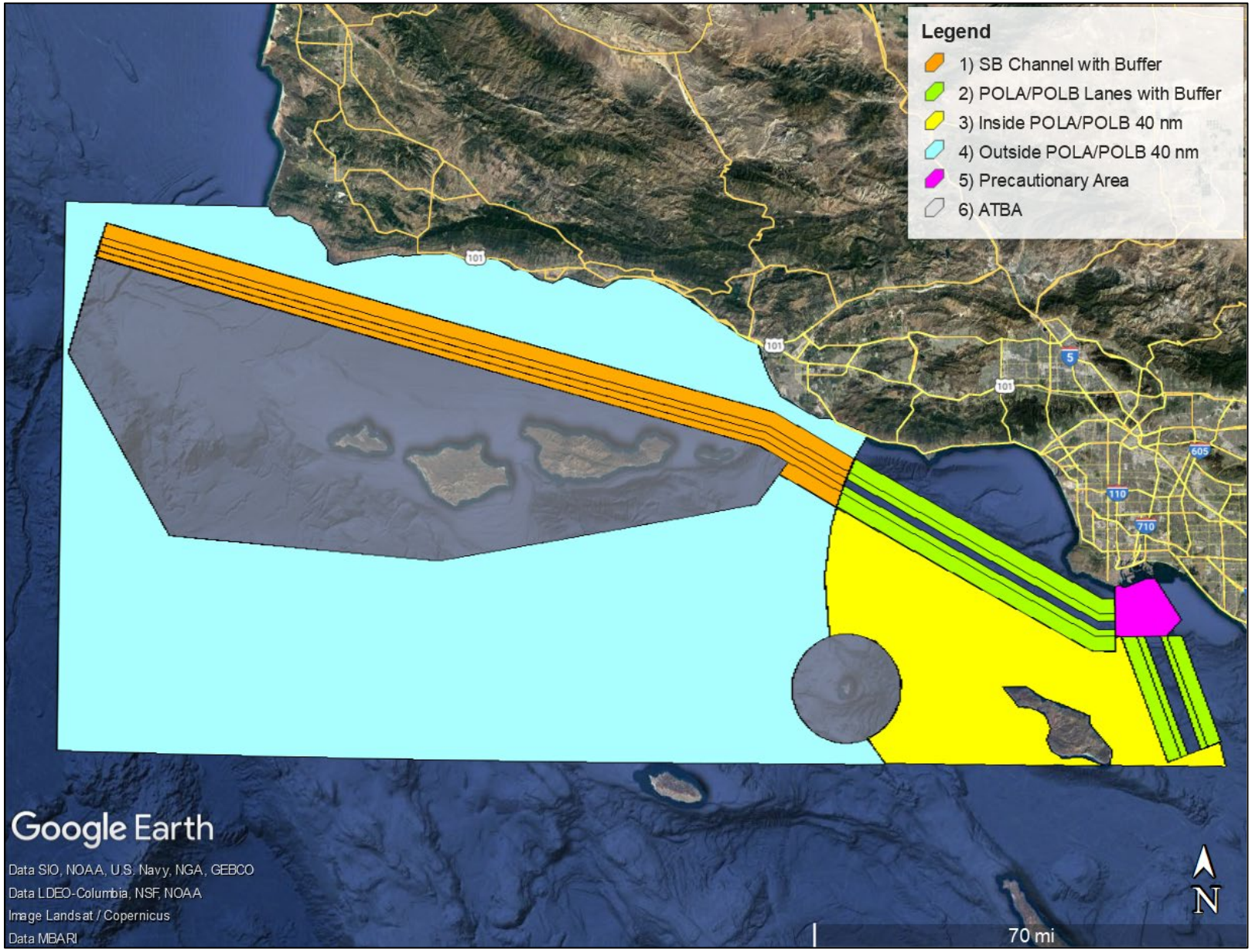
Results, Total	**# Vessels**	**Baseline Emissions**				**2024 Emission Reductions**			
		NOx *(tons)*	**SOx** *(tons)*	**DPM** *(tons)*	**CO_2E** *(tonnes)*	**NOx** *(tons)*	**SOx** *(tons)*	**DPM** *(tons)*	**CO_2E** *(tonnes)*
	743	5,198	121	41.3	181,923	1,405	33	8.4	49,945
Results, by Ship Type									
Container	362	4,373	99	32.8	149,886	1,233	27	5.8	41,280
Auto	220	405	10	4.0	15,414	88	3	1.0	4,098
Tanker	65	275	7	2.9	10,996	46	2	0.9	2,736
Bulk/General	96	146	4	1.6	5,625	38	1	0.7	1,831
Results, by Region									
SF & Monterey	425	1,060	25	8.7	37,185	314	7	1.9	10,762
Southern CA	706	4,138	96	32.6	144,737	1,091	26	6.5	39,183

To compare the 2024 season results to prior seasons and to demonstrate the on-going success and benefits of the BWBS VSR Program, the results from all VSR seasons are included in Table 7 below.

Table 7: Summary of BWBS Air Emission Reductions – By Year

VSR Season	Duration	Basis	# Vessels	Emission Reductions			
				NOx *(tons)*	**SOx** *(tons)*	**DPM** *(tons)*	**CO_2E** *(tonnes)*
2014	4 months	Transit	14	12	0.4	0.1	537
2016	4.5 months		25	26	0.7	0.3	1,007
2017			44	84	1.9	1.1	2,630
2018		Fleet	295	266	6.0	2.6	8,668
2019	6 months		349	536	12	4.8	17,026
2020			482	748	16	4.8	24,258
2021			545	650	15	2.7	22,201
2022	7.5 months		671	921	22	4.7	32,604
2023			709	1,256	30	6.3	45,784
2024	8 months	Fleet	743	1,405	33	8.4	49,945
			Total:	**5,903**	**137**	**35.6**	**204,661**

Appendix A: Southern California Methodology Map



Appendix B: San Francisco Bay Area and Monterey Bay Methodology Map