Public Workshop
Vessel Speed Reduction for Ocean-Going Vessels
Sacramento
July 29, 2009

Air Resources Board
California Environmental Protection Agency

Overview

- Background
- Emissions and Emissions Reductions
- Modeling and Health Impacts
- Cost
- Vessel Speed Reduction Survey
- Issues/Considerations
- Next Steps

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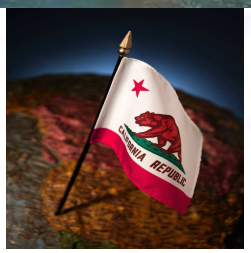
Background



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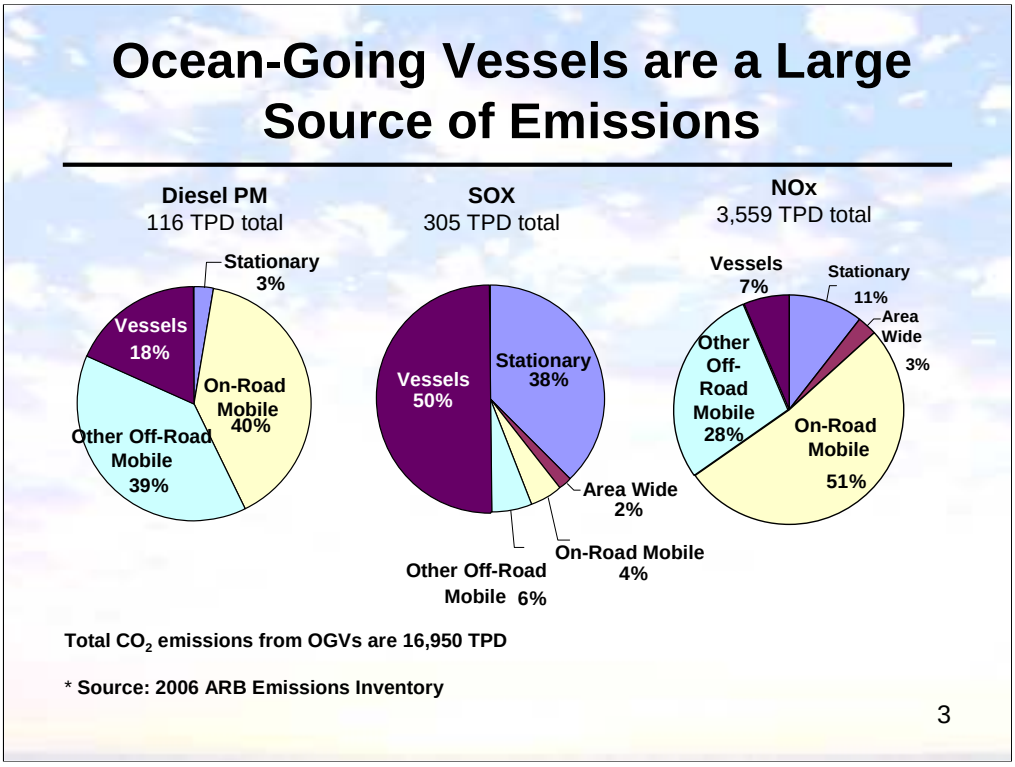
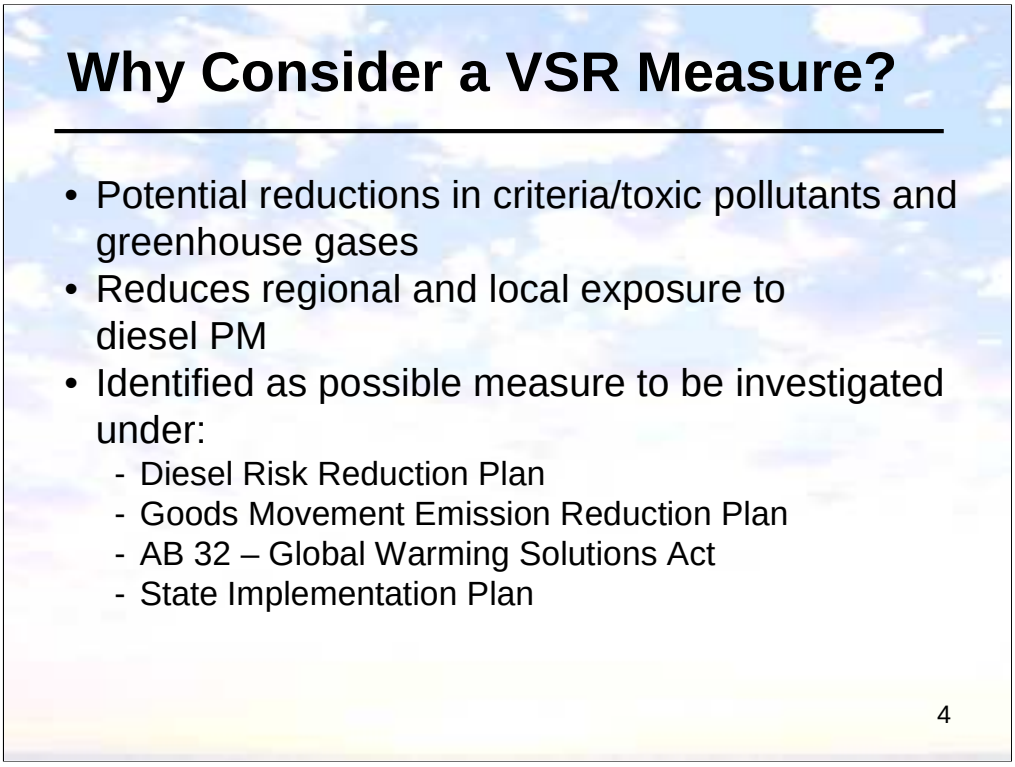


Just to give you some perspective on just how significant the emissions from ocean-going vessels are, we have put together some pie charts showing you the total tons per day of emissions from ships with comparison to other sources.

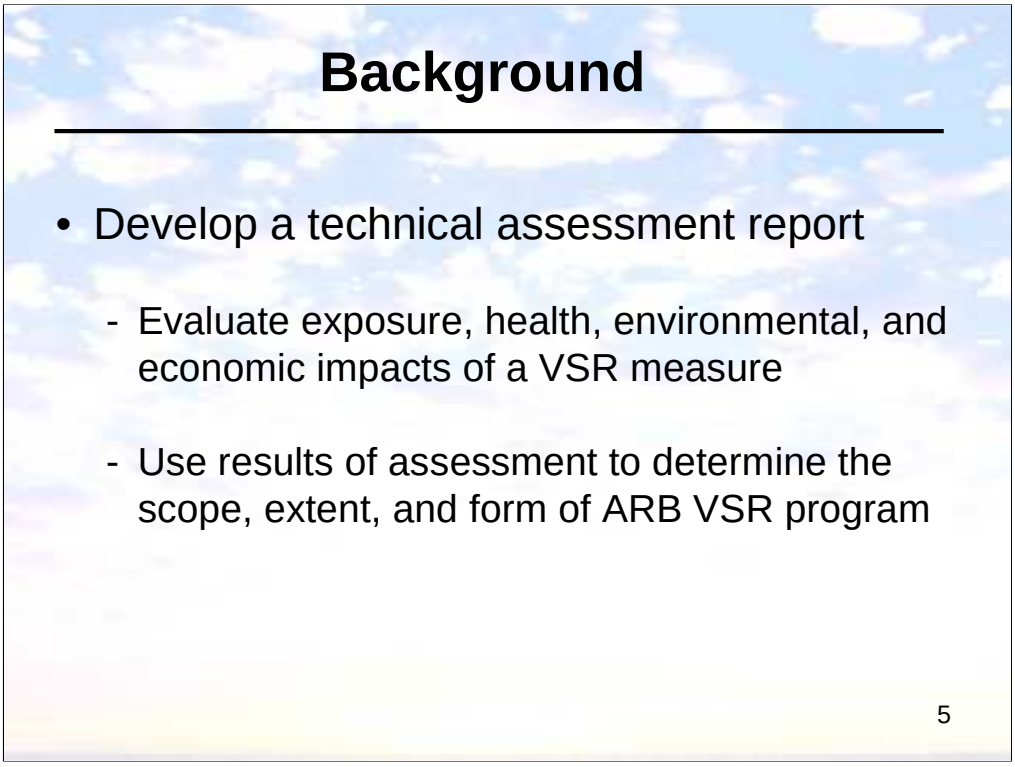
As you can see (in the dark purple area), in 2006 ocean-going vessel emissions accounted for about 18 percent of the overall statewide diesel PM emissions, about 50% of the SOx emissions and about 7% of the NOx emissions.

In addition, in 2006 ocean-going vessels accounted for an estimated total of about 17,000 tons/day of CO_2 emissions.



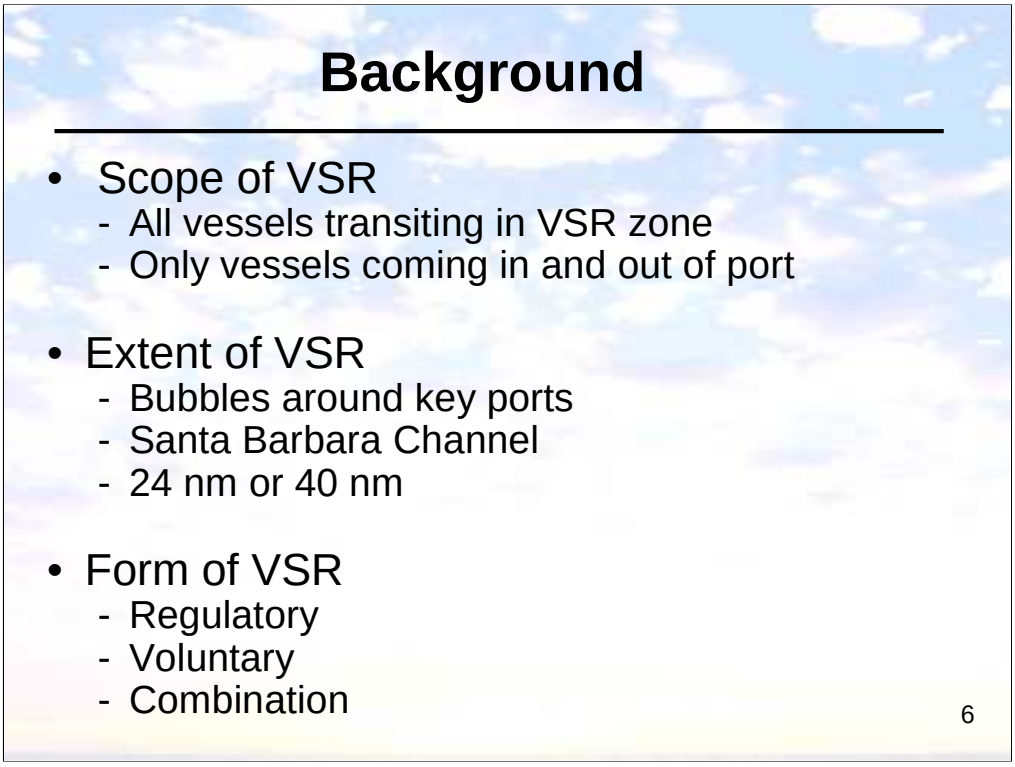
Why are we considering a VSR measure? As you will see in upcoming slides, there can be potential reductions in criteria and toxic pollutants as well as greenhouse gases. A VSR program can reduce regional and local exposure to diesel PM.

A VSR program has also been identified under several other ARB programs such as the diesel risk reductions plan, the Goods movement Emission Reduction Plan, the AB 32 Global Warming Solutions Act and the State Implementation Plan.



The results of our analysis will be assembled into a technical assessment report. In this report, we will evaluate the exposure, health, environmental and economic impacts that may occur as a result of a VSR measure or program.

These results will help us to determine the scope, extent, and form of ARB's VSR program.



As part of the scope of the assessment, we are evaluating emissions for all vessels transiting within a VSR zone as well as those vessels coming in and out of port only.

The extent of a VSR program considers VSR zones or bubbles around key ports and within the Santa Barbara channel. These locations will be considered at both 24 and 40 nm.

The form of the program or measure could be regulatory, voluntary, or a combination of the two.

Emissions and Emissions Reductions

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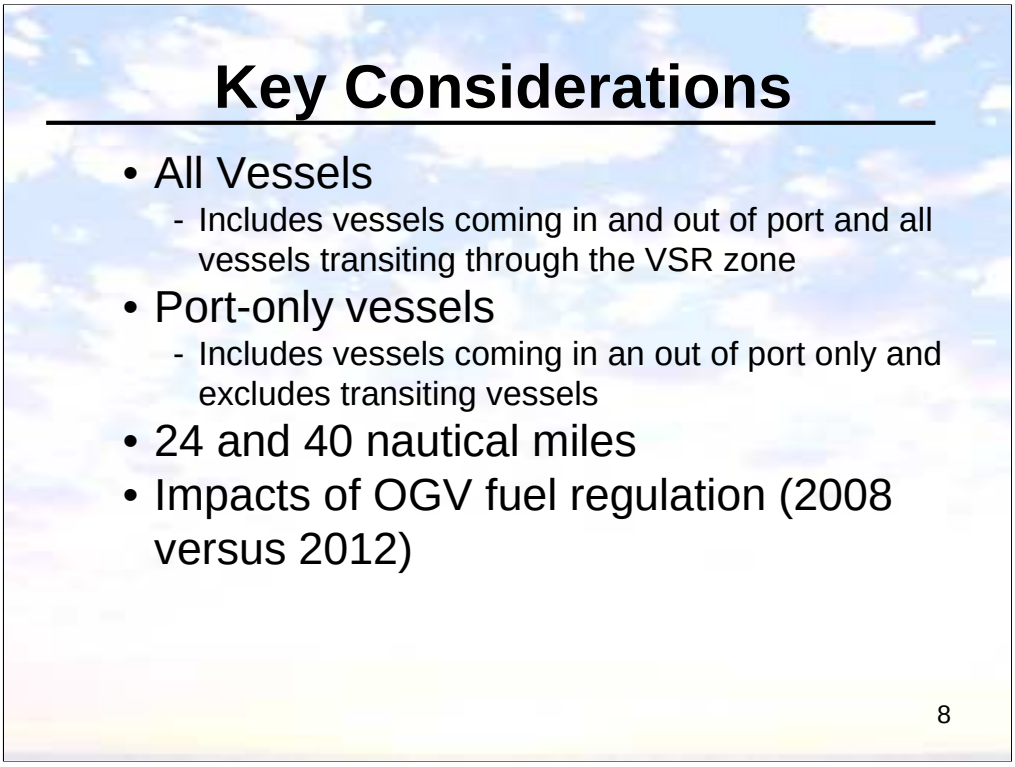
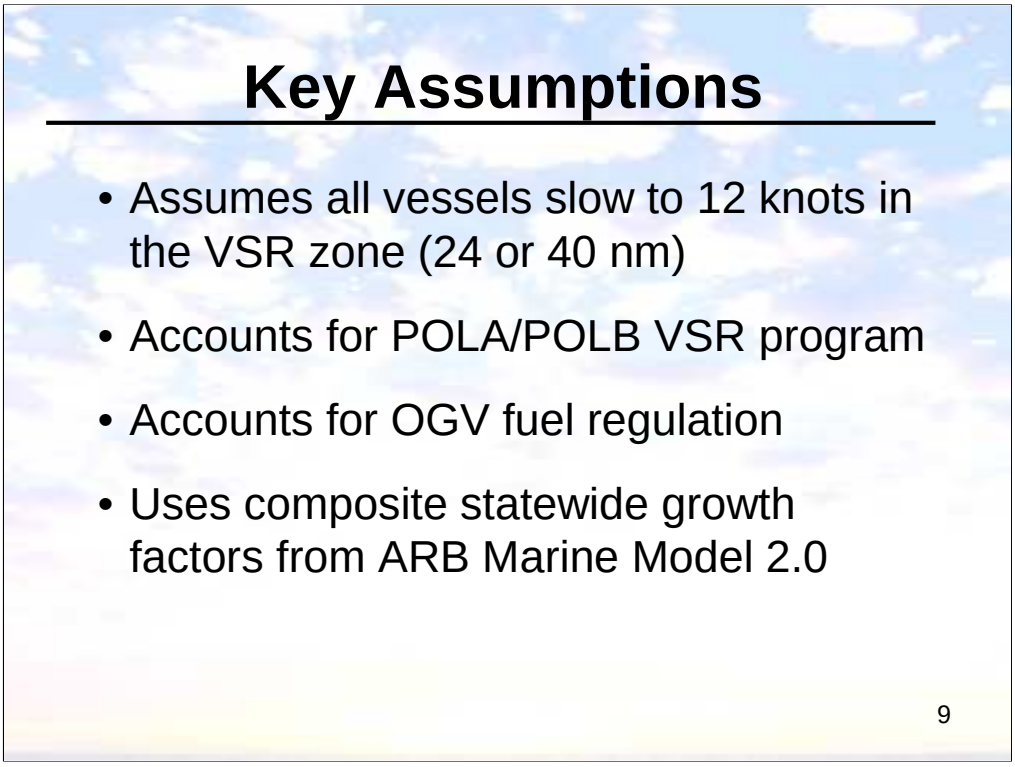


Before I discuss the emissions, some of the key considerations are presented on this slide. In our emissions analysis we have considered two emission scenarios: The all vessels scenario is when all vessels, including those transiting through the VSR zone, are slowed to VSR speeds. The port-only vessels include only those vessels coming in and out of port and excludes transiting vessels, whereby only port directed traffic is slowed.

Both the all vessels and port-only vessels scenarios looks at impacts from 24 and 40 nm. In addition, both scenarios include the impacts of the OGV fuel regulation for 2012.

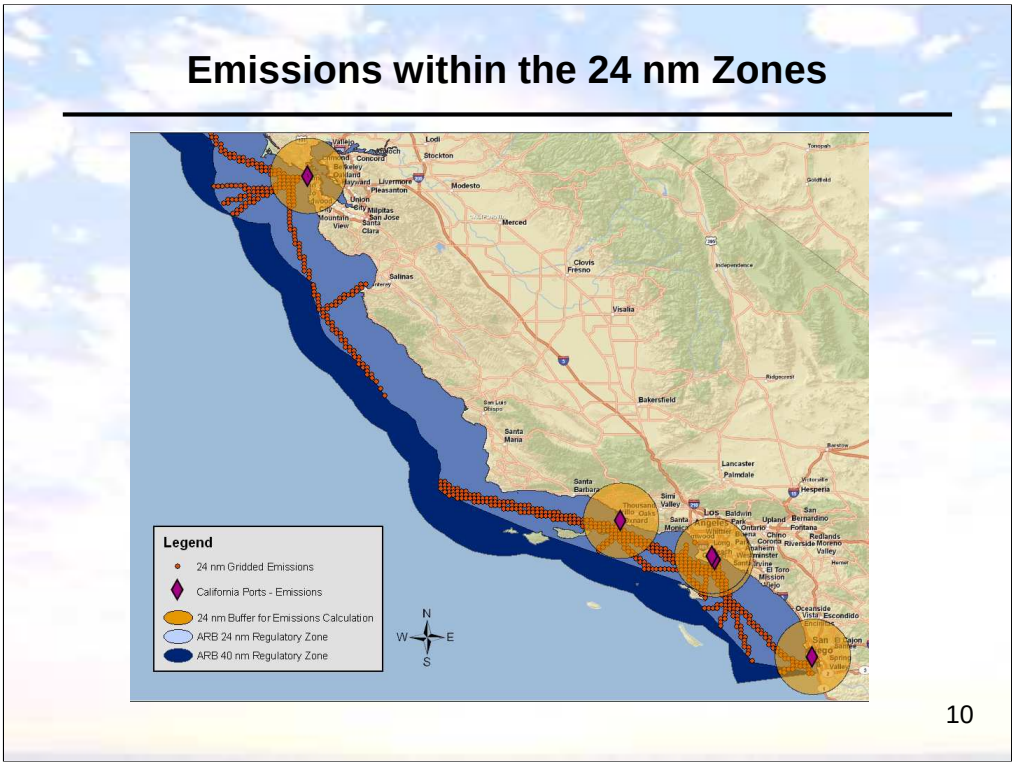


Here are some of the key assumptions used in our emissions inventory analysis.

We assume all vessels impacted by VSR slow to 12 knots in the VSR zone.

We have taken into account the voluntary program at POLA/POLB. We have assumed a compliance rate of 70% although we recognize it is now around 90%.

The emissions for 2012 take into account the OGV fuel regulation. We have used composite statewide growth factors from ARBs marine model which were also used in the OGV fuel regulation analysis. It is important to note that there is ongoing work at ARB to revise the growth factors. As these factors become available we will incorporate them into the emissions analysis.



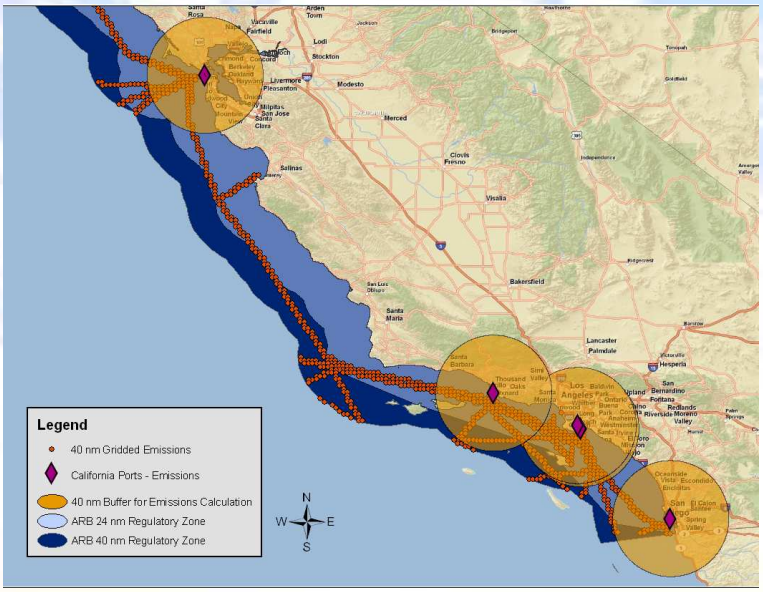
This slide illustrates the 24, and 40 nautical mile line along the California coast. The light blue region represents the 24 nm zone, and the darker blue region represents the 40 nm zone.

We have moved away from the concept of an entire coastal VSR program and moved to a port bubble concept which is shown in the gold circles. These circles highlight a 24 nm emissions zone that surrounds each of the five major ports where we have estimated OGV emissions. The purple diamonds represents the central location for each emission zone. Starting from the top of the slide, the Ports highlighted here include Bay Area Ports (includes all OGVs cross under the Golden Gate – e.g., go to San Francisco/Oakland/Richmond, etc.); Port Hueneme; POLA; POLB; and the Port of San Diego.

The lines of small orange squares represent the shipping lanes that fall within the 24nm zone. Each square represents a 4 square km cell where "gridded emissions" are quantified. These "gridded emissions" are used in the air dispersion modeling and are used to assess the health impacts near coastal communities.

Later, you will see a zone for the Santa Barbara channel where we will be modeling the emissions impacts.

Emissions within the 40 nm Buffer Zones



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In addition to 24nm, we also estimated emissions out to 40 nm around the same five California ports. The legend is identical as the earlier slide shown for 24 nm.

•gold circles and purple diamonds showing the ports or coastal locations and their domains.

•Dark blue shading outlines the 40nm buffer that parallels the coastline.

•Orange squares identify the gridded emissions from the shipping lanes that pass through each of the different buffer zones.

The emissions within 40 nm are also used in the modeling scenarios.

Emissions and Emissions Reductions[1,2]

Emissions with and without VSR for 2008
All traffic and port-only traffic for 24 and 40 nm
tons/day

Pollutant	Without VSR (24 nm)	With VSR: all traffic (24 nm)	With VSR: port only traffic (24 nm)	Without VSR (40 nm)	With VSR: all traffic (40 nm)	With VSR: port only traffic (40 nm)
Diesel PM	5.1	4.2	4.6	8.9	6.1	7.8
NOx	53	42	48	98	63	83
SOx	45	39	42	73	52	64
CO_2	3130	2720	2930	4810	3430	4250

1. Numbers are rounded
2. Estimates do not include OGV fuel regulation.

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This slide shows the emissions with and without VSR for 2008. This slide is the sum of all the 5 ports we discussed early. It includes emissions for all traffic and port-only traffic at both 24 and 40 nm. The first column shows the emissions without a VSR measure. The second column looks at emissions for VSR with all traffic and third column shows the benefit with a port only VSR Program.

The last 3 columns looks at the emissions for a 40 nm VSR program.

Overall, this slides shows that a port only VSR program gives you about one-half the emission reductions of an all traffic VSR program.

Emissions and Emissions Reductions[1,2]

Emissions with and without VSR for 2012
All traffic and port-only traffic for 24 and 40 nm
tons/day

Pollutant	Without VSR (24 nm)	With VSR: all traffic (24 nm)	With VSR: port only traffic (24 nm)	Without VSR (40 nm)	With VSR: all traffic (40 nm)	With VSR: port only traffic (40 nm)
Diesel PM	1.0	0.9	0.9	16.8	11.6	15.3
NOx	60	47	54	116	76	104
SOx	2.0	1.7	1.9	153	110	139
CO_2	3540	3080	3330	5790	4290	5320

1. Numbers are rounded
2. Estimates include OGV fuel regulation within 24 nm and includes statewide growth factors.

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This is the same slide as the previous except it considers emissions for 2012. Note that the OGV fuel regulation comes into effect for 2012 so the emissions for Diesel PM and SOx are significantly lower as compared to 2008, about 80 percent of the diesel PM and over 90% of the SOx emissions. The results show that the greatest emissions impact for a VSR measure beyond 2012 are seen in NOx reductions.

And like the previous slide for 2008, the port-only VSR gives provides about one-half of the emission reductions as compared to the all traffic VSR.

Emission Reduction Benefits for VSR at 24 nm

ALL TRAFFIC - 12 knot VSR Measure at 24 nm (tons per day)

Ports	Diesel PM	NOx	SOx	CO_2
2008				
Los Angeles/Long Beach	0.07	1	0.6	41
San Diego	0.04	0.5	0.3	21
Bay Area	0.4	4.6	2.7	167
Hueneme	0.4	4.8	2.8	180
Total	0.9	11.2	6.4	409
2012				
Los Angeles/Long Beach	0.01	1.1	0.03	46
San Diego	0.008	0.6	0.01	23
Bay Area	0.07	5.4	0.1	187
Hueneme	0.09	6.0	0.1	201
Total	0.18	13.1	0.24	457

Numbers are rounded

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This slide shows the all traffic emission reduction benefits for the major ports for Diesel PM, NOx, SOx and CO2. A similar type slide was presented at our last workshop, but I wanted to show it again to remind everyone what the "all traffic" emission reductions showed.

The all traffic emissions scenario shows that the largest reductions occur in the Bay Area and at Port Hueneme. Smaller reductions at LA/LB are due to the existing VSR program. San Diego also has less emission reduction benefit likely due to the types of ships coming into port which tend to have slower average speeds, such as tankers.

As mentioned in an earlier slide, due to the OGV fuel regulation emissions of diesel PM and SOx go down significantly in 2012.

Emission Reduction Benefits for VSR at 40 nm

ALL TRAFFIC - 12 knot VSR Measure at 40 nm (tons per day)

Ports	Diesel PM	NOx	SOx	CO_2
2008				
Los Angeles/Long Beach	0.6	7.3	4.5	283
San Diego	0.1	1.3	0.8	56
Bay Area	0.8	9.2	5.6	342
Hueneme	1.4	16.6	9.9	699
Total	2.9	34.4	20.8	1380
2012				
Los Angeles/Long Beach	1.2	9.1	9.8	354
San Diego	0.2	1.6	1.8	70
Bay Area	1.5	11.5	12.1	427
Hueneme	2.7	20.7	21.5	874
Total	5.6	42.9	45.2	1725

Numbers are rounded

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This slide shows emissions reduction out to 40 nautical miles. Note that in 2012 the benefits from the OGV fuel regulation apply only to those emissions between 0-24. Dirty fuel is assumed between 24 and 40 nautical miles.

Emission Reduction Benefits of VSR at 24 nm

PORT ONLY TRAFFIC - 12 knot VSR Measure at 24 nm (tons per day)

Ports	Diesel PM	NOx	SOx	CO_2
2008				
Los Angeles/Long Beach	0.03	0.5	0.3	24
San Diego	0.04	0.5	0.3	21
Bay Area	0.29	3.7	2.2	136
Hueneme	0.03	0.3	0.1	11
Total	0.39	5.1	2.9	192
2012				
Los Angeles/Long Beach	0.006	0.6	0.01	27
San Diego	0.008	0.6	0.01	23
Bay Area	0.06	4.2	0.09	154
Hueneme	0.006	0.4	0.005	12
Total	0.080	5.8	0.13	216

Numbers are rounded

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This slide shows the emission reduction benefits for Port Only traffic at the major ports for Diesel PM, NOx, SOx and CO2. The port only traffic only takes into account slowing the vessels that are coming in and out of port only. The overall benefits due to port only traffic are about half of those seen in the all traffic scenario.

As you can see, this makes a big difference in calculating the benefits from these ports. For example, the benefits for Port Hueneme drop significantly as compared to the all traffic emissions reductions. This is because a very small percentage of the ships transiting through the 24 nm Port bubble make port calls. For the other ports, the vast majority of the vessels transiting through also come to port. Therefore, the emissions benefits for the remaining ports are similar for the all traffic and port only traffic.

Emission Reduction Benefits of VSR at 40 nm

PORT ONLY TRAFFIC - 12 knot VSR Measure at 40 nm (tons per day)

Ports	Diesel PM	NOx	SOx	CO_2
2008				
Los Angeles/Long Beach	0.4	5.9	3.7	234
San Diego	0.09	0.7	0.5	31
Bay Area	0.6	7.5	4.5	273
Hueneme	<0.001	0.2	<0.001	19
Total	1.1	14.3	8.7	557
2012				
Los Angeles/Long Beach	1.0	7.3	8.1	292
San Diego	0.2	0.9	1.0	38
Bay Area	1.2	9.3	9.7	341
Hueneme	0.2	0.3	<0.001	23
Total	2.6	18.0	18.8	695

Numbers are rounded

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This is the same slide as the previous, except that it is for 40 nautical miles. Again, as compared to the all traffic scenario, the emission reductions at Port Hueneme are very small.

Emission Observations

- The all traffic and port-only traffic scenarios show similar benefits, except Port Hueneme
- Port Hueneme
  - Little emissions benefit from the port-only traffic emissions scenario. Most emissions come from transiting through VSR zones.
- In 2012 the use of clean fuels can significantly reduce diesel PM and SOx within 24 nm
  - Approximately 80% in diesel PM
  - Approximately 90% in SOx

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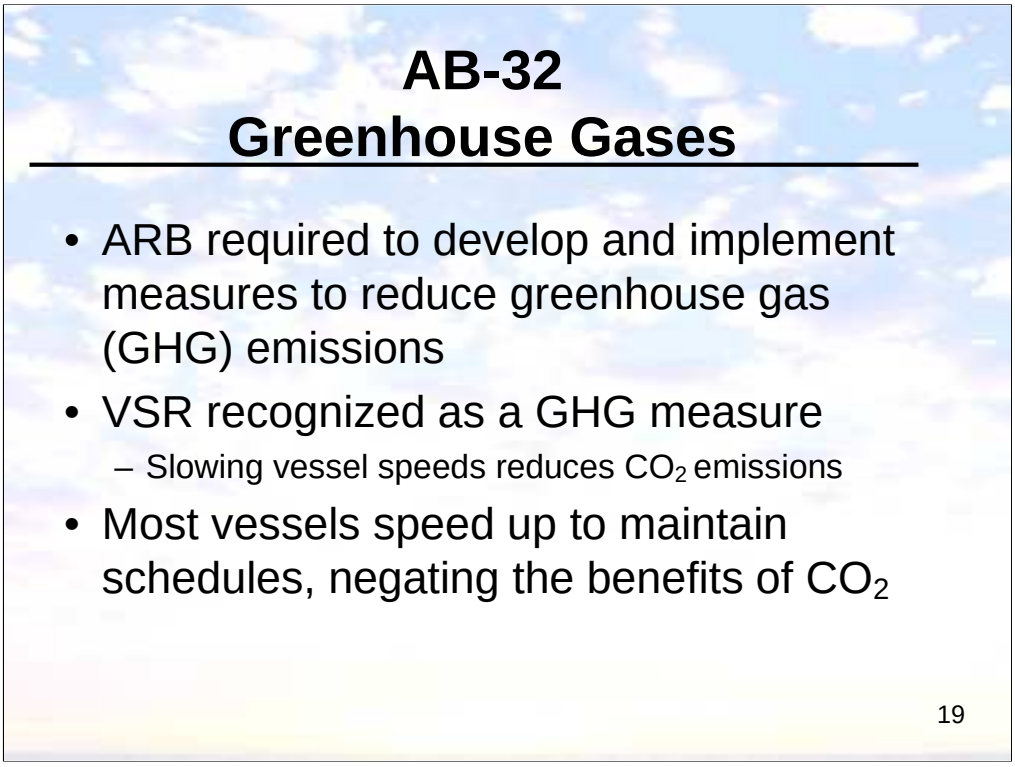
This slide shows the observations made when comparing the all traffic and port only traffic scenarios on a port-by-port basis.

With the exception of Port Hueneme, both scenarios show similar benefits. As mentioned earlier very little emissions benefit from the port-only emissions scenarios.

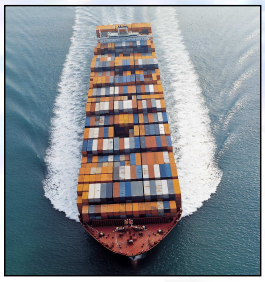
In 2012 the use of clean fuels reduce the emissions of diesel PM by about 80% and Sox about 90% within 24 nm.



In 2006, the Legislature passed and the Governor signed Assembly Bill 32, the Global Warming Solutions Act of 2006, which set the 2020 greenhouse gas reduction goal into law. It directed ARB to develop and implement measures to reduce GHG levels to 1990 levels. Vessel speed reduction has been identified in the draft scoping plan as a greenhouse gas measure under the Transportation Sector.

Based on our survey results and discussions with industry, it appears that most vessel operators speed up to maintain their schedules. And due to the increases in fuel consumed, we believe that the benefits of CO2 could be negated.

Modeling and Health Impacts



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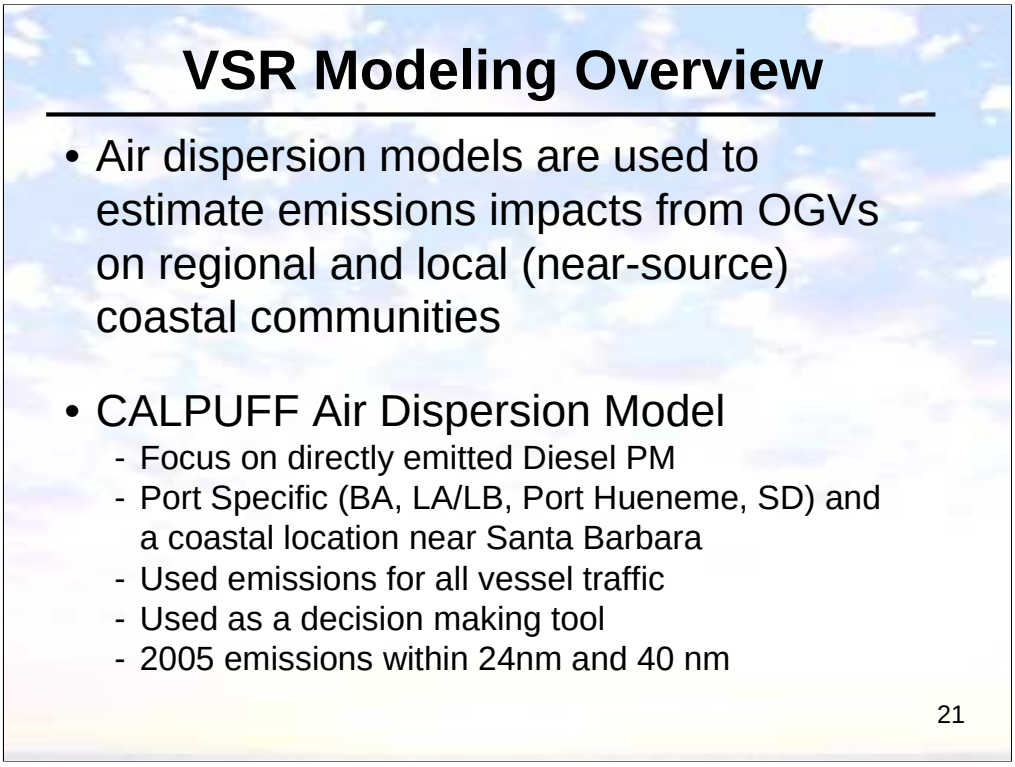
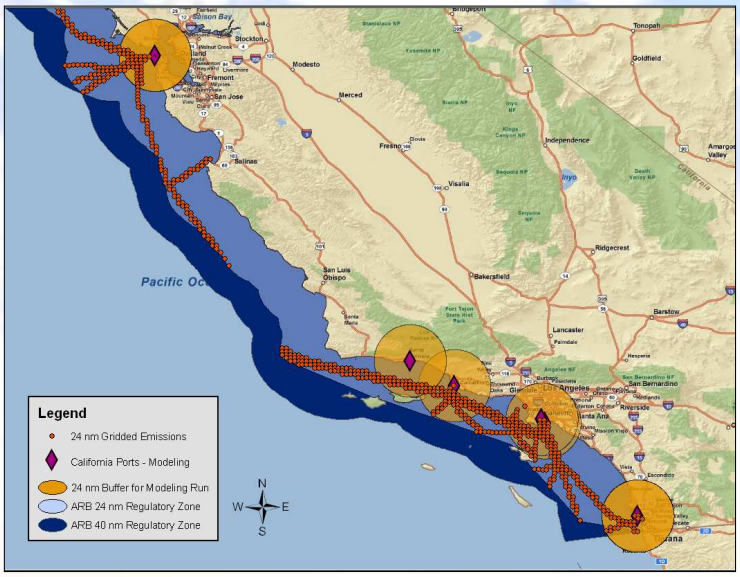


Air dispersion models are used to estimate emissions impacts from OGVs on regional and local coastal communities. For our modeling analysis we are using the Calpuff Air Dispersion Model which estimates concentrations for directly emitted diesel PM and will provide concentrations for the major ports and at a coastal location near Santa Barbara. We are using the emissions for all vessel traffic for the year 2005 at 24 and 40 nm.

Air Dispersion Modeling (24 nm)



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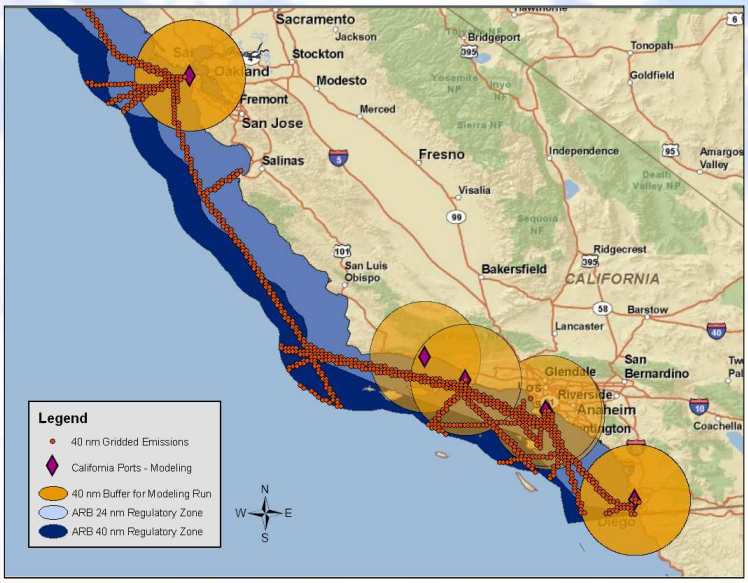
This slide illustrates where we plan to model around the major ports and at a coastal location near Santa Barbara. The legend is the same as the earlier slides, but the locations depict the emissions that will be used in our modeling analysis.

Air Dispersion Modeling (40 nm)



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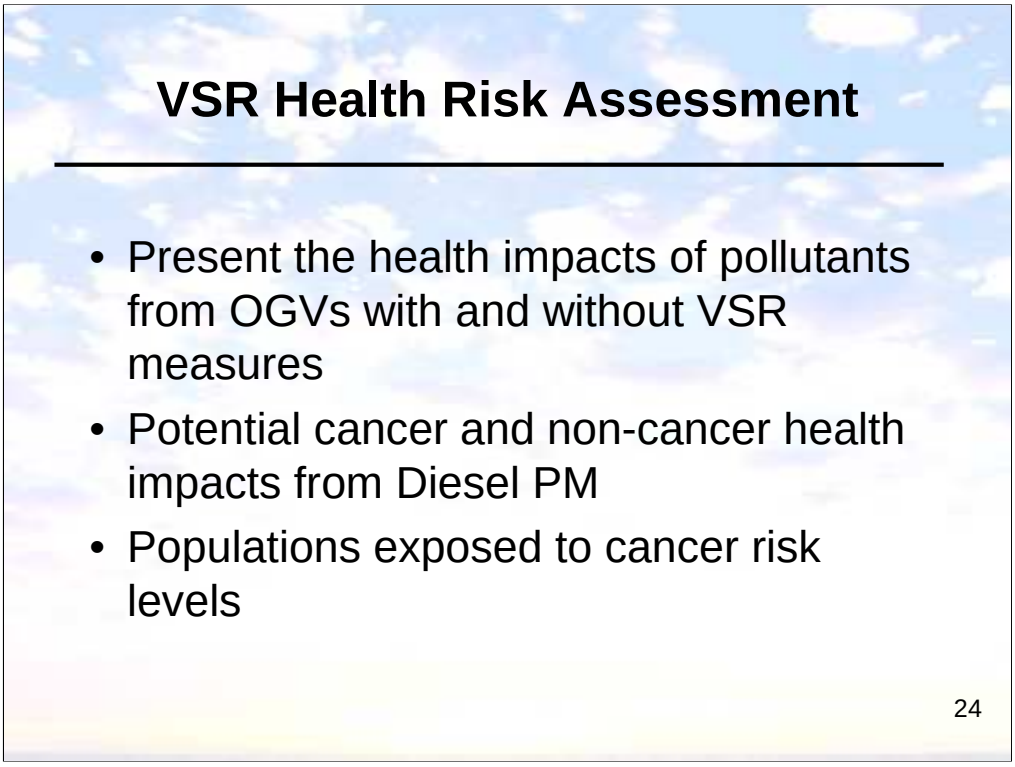
This slide illustrates where modeling will take place within **40nm** of the coastline around the major ports and at the coastal location near Santa Barbara.

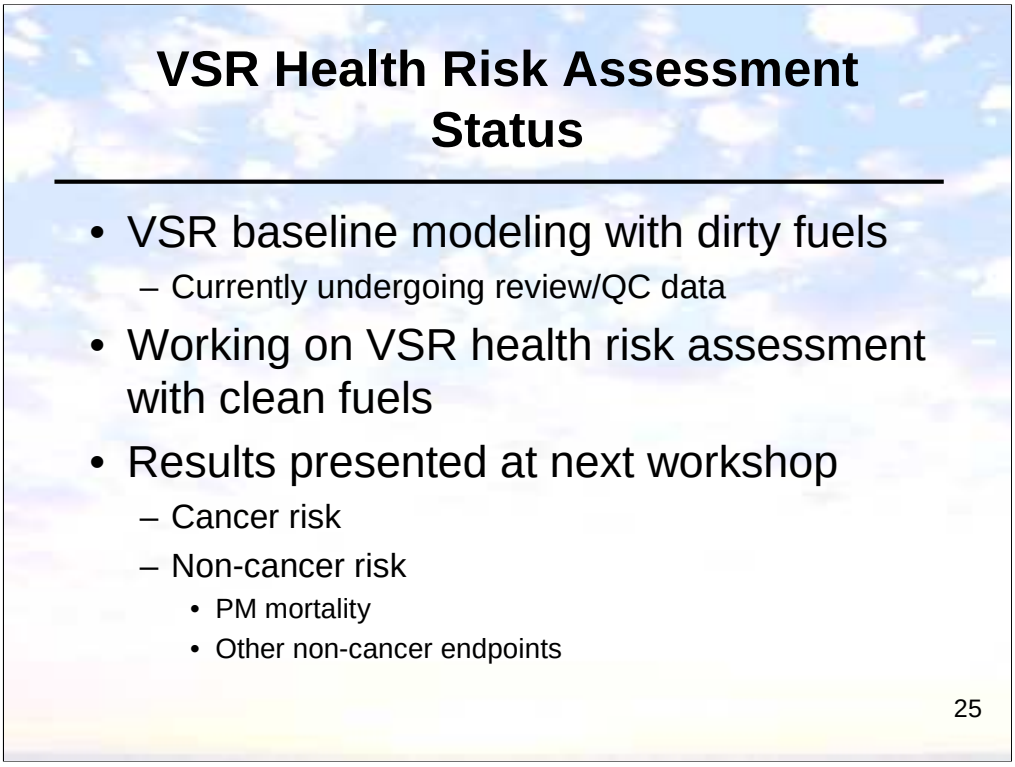


In this VSR health risk assessment, we are evaluating the impacts of vessel speed reduction on the emissions from Ocean Going Vessels.

We will be presenting the potential health impacts from exposure to directly emitted diesel PM.

Currently, we are evaluating the potential carcinogenic impacts of directly emitted PM from OGV diesel engines with and without the implementation of VSR measures. We also will be presenting potential noncarcinogenic impacts from directly-emitted PM. Examples of potential health impacts may include premature death (mortality), asthma, bronchitis, other respiratory impacts, work loss days, etc.

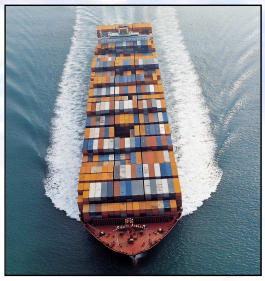
We will also be looking at populations exposed to cancer risk levels.



Modeling and health risk assessment is currently underway. We have completed the VSR modeling which is currently undergoing internal review. This work has been done with 2005 dirty fuels. We will be remodeling those emissions making adjustments for the OGV fuel regulation which goes into effect in 2012.

At the next workshop we will present the results of the cancer risk and non-cancer risk assessment.

Cost



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Cost Methodology

- Port Costs (i.e., administrative, vessel monitoring, dockage fees, enforcement)
- Vessel owner/operator costs (i.e., onshore labor, crew supplies, maintenance, onboard labor, general overhead)
- Fuel costs & benefits

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This slide shows the types of cost associated with a VSR program. If the port were to administer a VSR program, the costs that could be incurred would include administrative, vessel monitoring, dockage fees, and enforcement.

Potential costs for vessel owner/operators could include things such as onshore labor, crew supplies, maintenance, onboard labor and general overhead.

We are also looking at fuel cost and savings.

Summary of Cost Data

- Vessel owner/operators daily cost due to a one hour delay (time it takes to slow vessel to 12 knots out from 24 nm) range from $250 to $600
- Port costs could range from $50,000 to $100,000 per year (POLA/POLB administrative costs)
- Fuel cost benefits within VSR zones
- Potential fuel cost increases outside VSR zone due to increased speeds to make up for lost time

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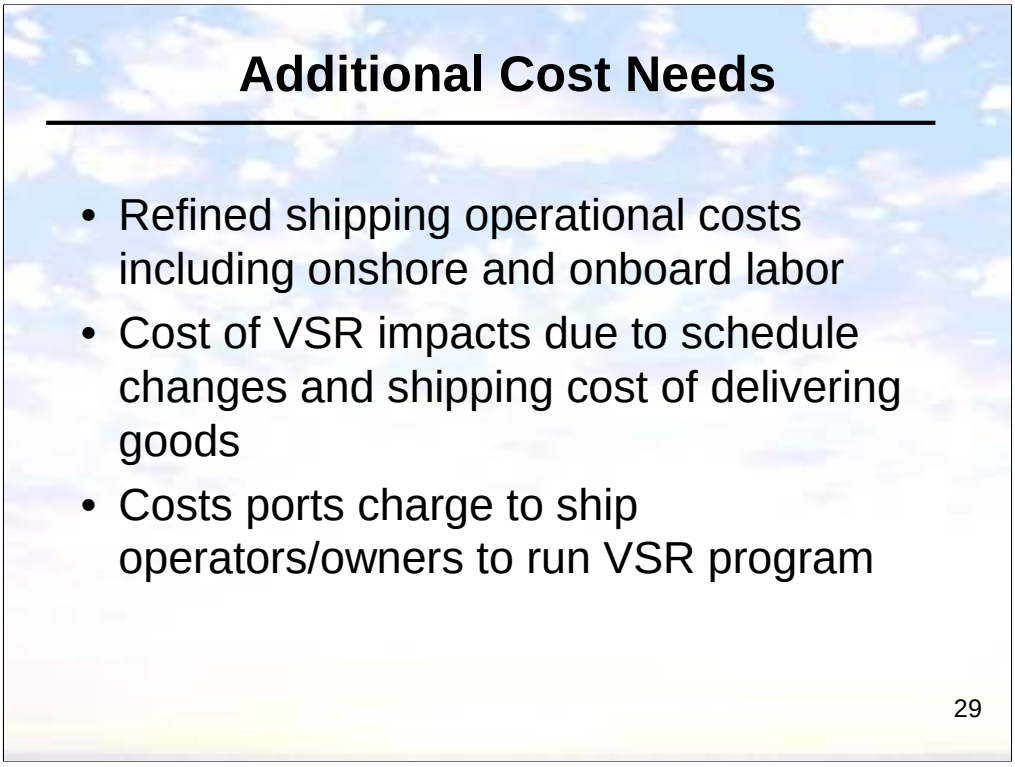
This slide presents some preliminary information we have on costs. Based on our survey results, the average vessel weighted daily costs for vessel operators ranged from about $250 to $600. The majority of these costs came from increased costs in crew and maintenance.

Administrative costs for ports could range form $50,000 to $100,000

However, many vessel operators have indicated they do speed up outside of the VSR zone and could therefore have an overall increase in fuel use. However, we believe the amount of fuel used is a result of vessels increasing speed.



Additional cost needs include more refined costs to shippers including onshore and onboard labor. How VSR impacts scheduling and costs of delivering goods.

We need to examine potential costs that ports could incur and if they pass those costs on to ship operators.

Vessel Speed Reduction Survey

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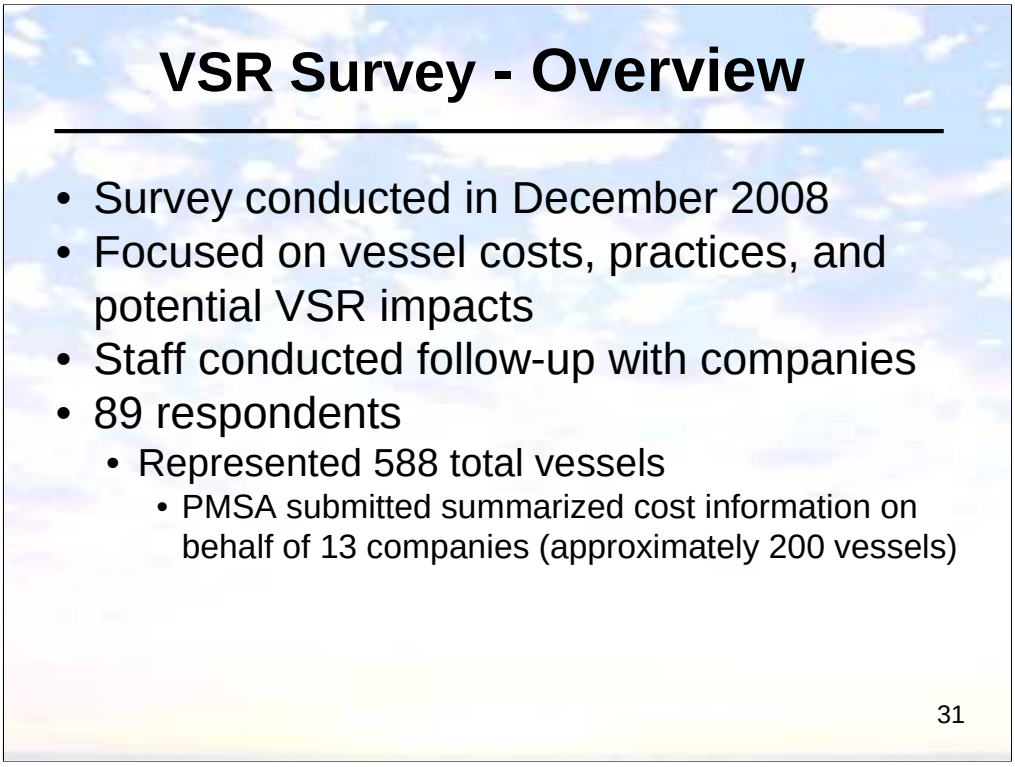

Last December, ARB staff sent out a survey to get a better understanding on how a VSR program could impact vessel costs, speed practices, and other impacts, such as fuel use and the potential for rerouting when a VSR measure is in place. Staff conducted extensive follow-up with vessel operators where critical information was missing.

Overall, we had 89 survey respondents which represented almost 600 vessels. PMSA submitted summarized cost information on behalf of 13 companies.

VSR Survey - Overview

Vessel Information Summary from 89 Survey Respondents Representing 58 Companies

Vessel Type	Number of Vessels	% of Total Vessels
Container	252	43
Tanker	127	22
Auto	84	14
Bulk	56	9
General	28	5
Cruise	23	4
RoRo	15	3
Other	3	<1
Total	**588**	**100**

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This table shows vessel respondents by vessel type. As you can see, responses from container vessels make up the largest portion of the responses, about 42% of all vessels, followed by tankers at 22%.

Survey Conclusions

- Most vessel operators indicated that they would have increased operating costs when complying with VSR
- Shipping owner/operators daily cost due to a one hour delay (VSR at 24 nm) range from $250 to $600

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The next few slides shows our survey conclusions. Most vessel operators indicated that they would have increased operating costs when complying with VSR.

Many of the increased costs reported in the Survey included onboard labor, maintenance, and increased fuel use.

As mentioned earlier our survey showed an average vessel weighted daily cost from $250 to $600 assuming a one hour delay. This range does not include any fuel costs or savings.

Survey Conclusions (cont.)

- Most vessels will speed up outside the VSR zone to maintain schedule
  - Typically speed up by ½ knot or more
  - Potential increase in greenhouse gas emissions
- About half of the vessels indicated that they might change route or consider rerouting if VSR was implemented in the SB channel
- About 75% of vessels indicated they would comply with a voluntary VSR program entering or exiting major ports at 24nm

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Most vessels indicated they would speed up outside the VSR zone to maintain their schedule. Many indicated they would speed up by at least ½ knot or more.

About half of the vessels indicated that they might change their route or consider rerouting if VSR was implemented in the SB channel.

About 75% of the respondents indicated they would comply with a voluntary VSR program.

Survey Conclusions (cont.)

- About half of the vessel owners/operators have concerns about slow speed vessel operations on the maintenance and wear of the engine
- Vessel owners believe that reducing port fees is the most important incentive in a VSR program

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About half of the vessel operators expressed concerns about maintenance and wear of the engine while maintaining slow speeds. Some of the examples provided were fouling of the exhaust gas economizers due to incomplete combustion at low load and undue wear of the main engine due to increased liner and ring wear.

Vessel owners indicated that reducing port fees in the most important incentive for a VSR program. Non-financial incentives, such as the Green Flag program at the Port of Los Angeles was also important.

Issues/Considerations

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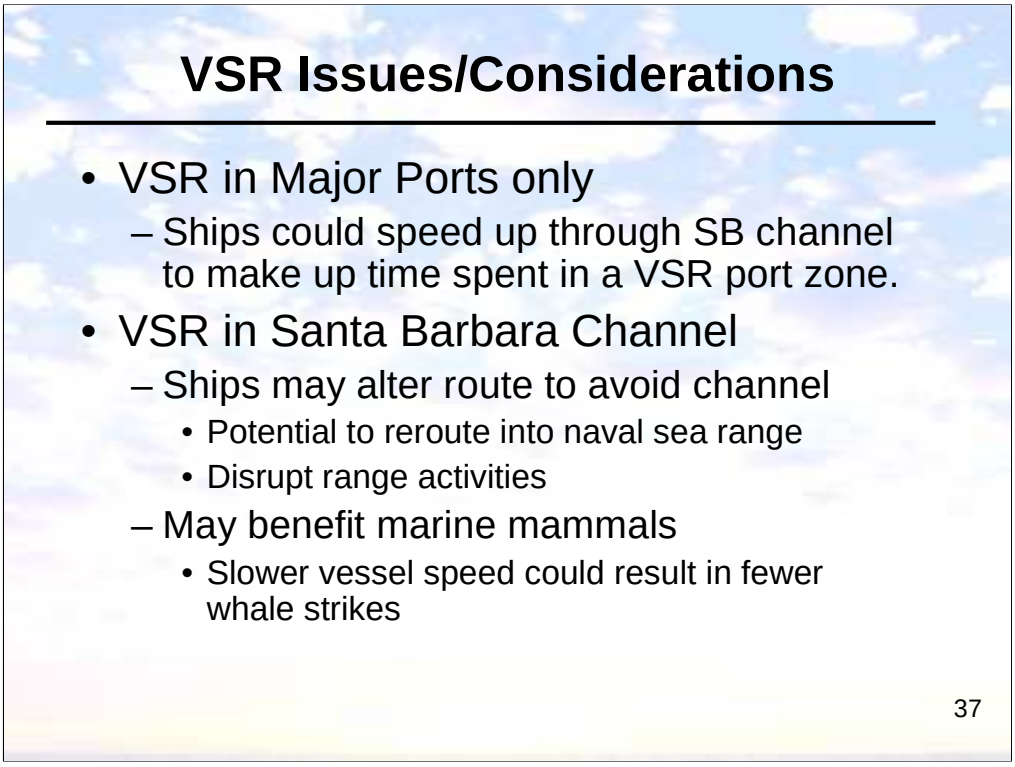

A VSR zone at major ports could cause some issues along the coastline. For example, ships traveling to and from the Bay Area ports from southern California may increase speeds in locations such as the Santa Barbara Channel, thus potentially increasing emissions to those coastal communities.

Additionally, vessels may alter their route to avoid a VSR zone in the Santa Barbara channel. One routing change would be to travel through the Point Mugu naval sea range, which could disrupt sea range activities.

There have been concerns over whale strikes in the Santa Barbara channel so slowing vessel speeds through the channel could result in fewer whale strikes.

Next Steps

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As mentioned earlier, we are continuing work on our modeling and health risk assessment. We have additional work modeling with clean fuels. Along with cancer risk, non-cancer impacts will also be included in the assessment.

We will be looking at the impact on marine mammals in the channel and Point Mugu Sea Range. The Channel Islands National Marine Sanctuary Advisory Council has been evaluating strategies to reduce the threat of whale strikes. The council has developed a list of recommendations to provide to NOAA on the ship-strike issue.

We will continue to refine our cost information and do data analysis on our survey results.

We just completed a contract to get current and historical AIS speed data for all major ports in California. We are working on setting up a receiver along the Santa Barbara coast to obtain speed data for the channel.

We have been working with ARB's goods movement group to understand how a VSR program could impact overall goods movement. For example, we are looking at the overall emissions impacts if vessels were to skip ports due to VSR and choose to either truck or rail their goods to their destination.

As discussed earlier, the information collected from our analysis will be presented in a technical assessment report which will be available for comment. We plan to release that report near the end of the year.

Our next workshop will be in the Fall where we will present our health risk assessment findings and additional information that we are working on.

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