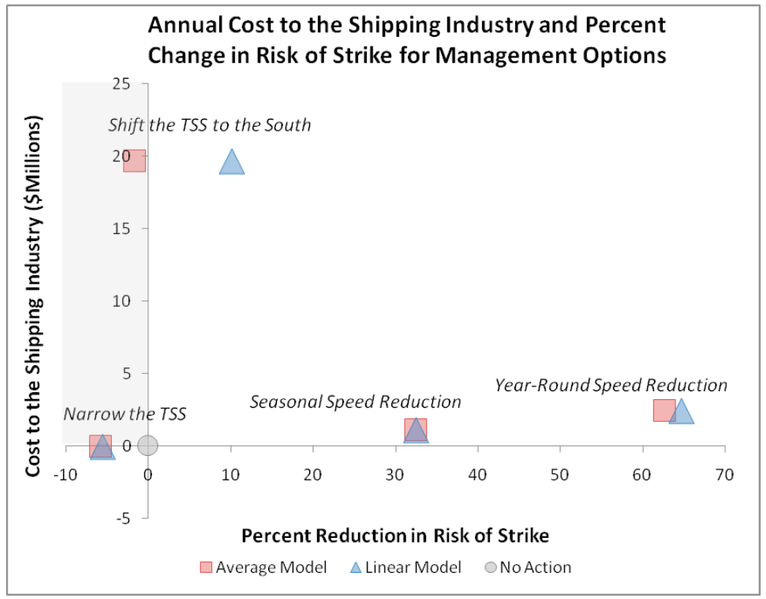
Conclusions



The figure above compares the reduction in relative risk of a lethal strike and the annual costs to the shipping industry for each of the four management options. The risk reduction calculated using both the Average Distribution Model (red boxes) and the Linear Model (blue triangles) is compared to the anticipated cost of each management option, which assumes each vessel operator chooses whether to make up lost time based on the least-cost option. The gray box indicates both a cost to the shipping industry and an increase in risk. The gray dot (0, 0) represents the change in risk and cost if no action is taken and current management conditions prevail. An acceptable management option should thus fall to the right of this point, which results in a reduction in risk and either a cost or savings to the industry.

Overall, our analysis predicts that the greatest reduction in the relative risk of a lethal whale strike occurs under the mandatory speed reduction scenarios, which result in the greatest reduction in relative risk per dollar cost to the industry. A year-round speed restriction reduces the relative risk of a lethal strike by 25.7% per $1 million of cost to the shipping industry, while a seasonal speed restriction reduces the relative risk of a lethal strike by 30.4% per $1 million of cost. Although narrowing the TSS results in a cost savings to the industry, our models indicate that this option would also increase the relative risk of a lethal strike. Shifting the TSS south of the Northern Channel Islands was not only the most expensive option, but may also increase the relative risk of a lethal strike.

Ultimately, the framework we have developed can be used to analyze the cost effectiveness of potential management scenarios for reducing the risk of vessel strikes to whales in any region where strikes occur.

Key Findings

A year-round or seasonal speed reduction may be the most cost-effective management option.

Narrowing or shifting the Traffic Separation Scheme to the south of the Northern Channel Islands may result in an increased risk of vessel strikes to whales.

Further analysis is needed to assess the effectiveness of management options in reducing the risk of a vessel strike.

The methodology developed in this project may be revised and expanded to evaluate the reduction in risk and the economic impact of management options for reducing the risk of vessel strikes to whales in any region where vessel strikes occur.

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Reducing the Risk of Vessel Strikes to Endangered Whales in the Santa Barbara Channel

An Economic Analysis and Risk Assessment of Potential Management Scenarios

Photo credit: John Calambokidis, Cascadia Research Collective

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Monica DeAngelis and Tina Fahy, National Marine Fisheries Service

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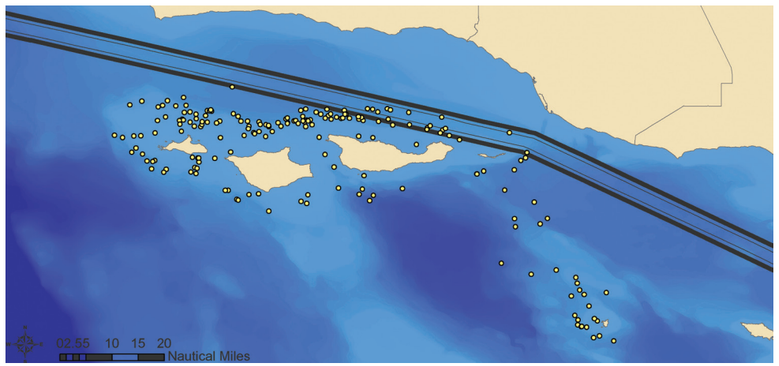
One of the most productive oceanographic regions in the world, the Santa Barbara Channel represents an especially important feeding ground for migrating and resident populations of endangered blue, fin, and humpback whales. The Channel region is also a major shipping thoroughfare used by thousands of ships annually. Current traffic lanes officially designated by a Traffic Separation Scheme overlap with whale aggregation sites in the region, potentially placing endangered whales in the direct path of thousands of large vessels.

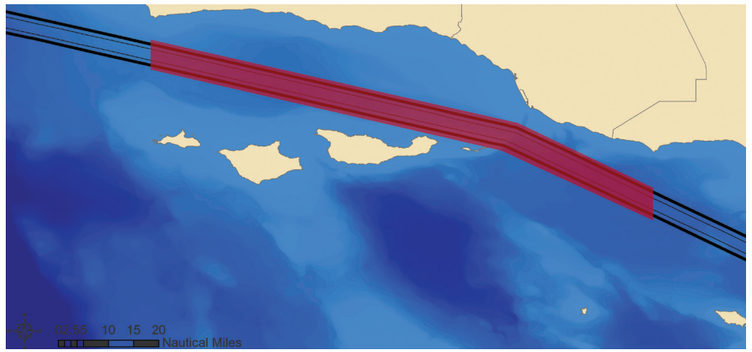
The co-occurrence of whales and ships increases the likelihood that a whale and a ship will interact, which in the most severe cases can lead to a lethal strike. In the fall of 2007 alone, four blue whales were struck and killed by ships in the Santa Barbara Channel region. NOAA's National Marine Fisheries Service (NMFS) declared this incident an Unusual Mortality Event and is now collaborating with the Channel Islands National Marine Sanctuary (CINMS) to evaluate possible long-term management options to decrease the risk of lethal vessel strikes to whales. The purpose of this project is to provide a framework for evaluating the economic impacts and risk implications of different management options designed to reduce the risk of lethal vessel strikes to whales in the Santa Barbara Channel region.



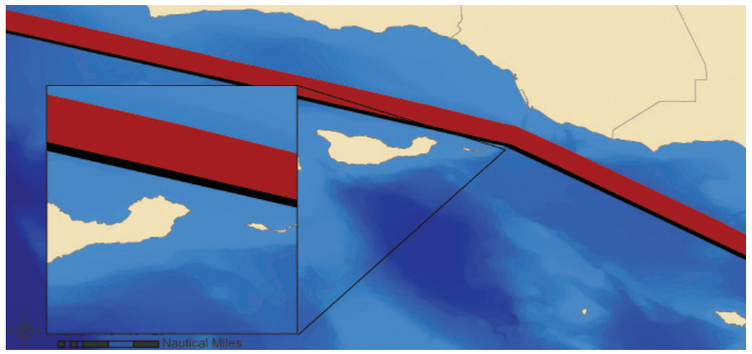
The Santa Barbara Channel region showing the existing Traffic Separation Scheme (black lines). Yellow points show locations of whales observed during CINMS aerial surveys.

Potential Management Options

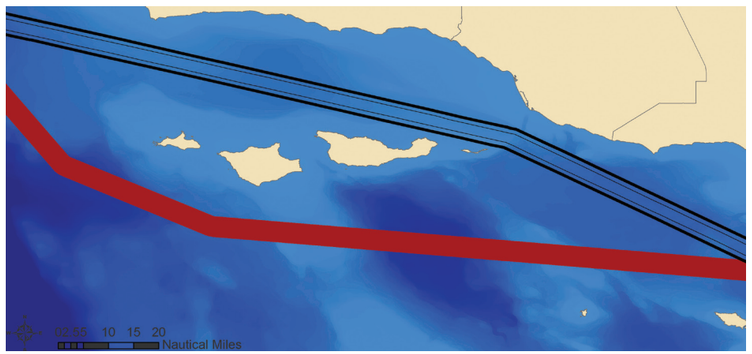
This project provides a framework by which NMFS and CINMS can evaluate both the risk implications and economic impacts of different management scenarios. Specifically, we considered the four potential management options outlined below.



MANAGEMENT OPTIONS 1 & 2
A year-long and seasonal (April through September) mandatory vessel speed reduction to 10 knots within the Whale Advisory Zone (shown in red), an 88 nautical mile extent of the Traffic Separation Scheme (TSS) through the Santa Barbara Channel.



MANAGEMENT OPTION 3
Narrowing the existing TSS within the Channel. This option was modeled by decreasing the width of the existing TSS (shown in black) by 0.65 nautical miles. The narrowed TSS is shown in red.

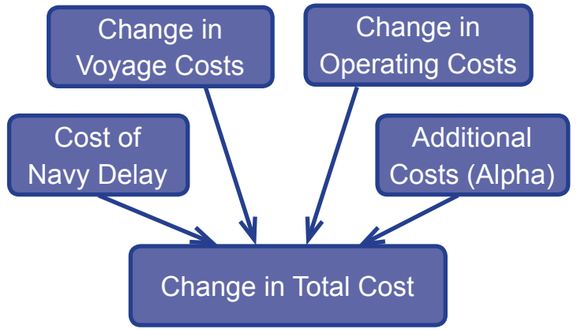


MANAGEMENT OPTION 4
Rerouting ships to the south side of the Northern Channel Islands. This option was modeled by establishing a hypothetical "Southern TSS" (shown in red), which increased the distance traveled by 13.8 nautical miles. The existing TSS is outlined in black.

To evaluate and compare these management options, we developed two models, one that estimates the change in relative risk of a lethal strike based on predicted whale distributions and vessel traffic patterns, and a second that calculates the change in total cost to the shipping industry. By combining the results of these two models, we were able to determine which of the four management options resulted in the greatest reduction in relative risk per dollar cost to the shipping industry.

Economic Analysis

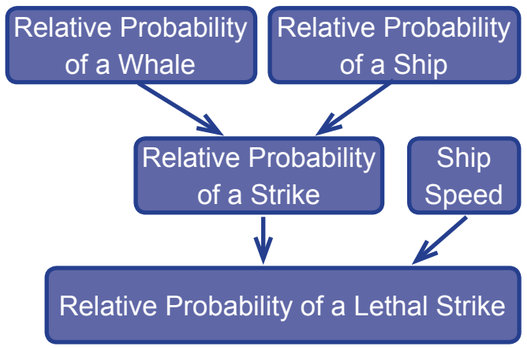
To determine the economic implications associated with each management option, we designed a model that estimated the annual change in total cost to the shipping industry, according to each management option. Change in cost was estimated by comparing the cost of a transit under the new scenario with the "status quo" cost of a transit based on past vessel behavior. Change in total cost (ΔTC) was calculated according to the following equation:



$$\Delta TC = \Delta VC + \Delta OC + \Delta NC + \alpha\Delta t$$

Where ΔVC represents the change in voyage costs, ΔOC represents the change in operating costs, ΔNC represents the change in cost from a delay due to a request by the Navy for the ship to alter course or speed, and αΔt represents an additional hourly factor for costs not otherwise accounted for within the other model components. In particular, ΔVC includes changes in fuel and lubricant costs, which are primarily due to increased distance traveled or changes in speed, while ΔOC includes changes in crew costs and additional repair and maintenance costs. For ships transiting to the south (Management Option 4), we also included the costs of unexpected delays that may result from Navy operations (ΔNC), which was calculated by multiplying the probability of a Navy request that a ship alter course or speed by the estimated costs resulting from a missed or delayed port call.

Risk Analysis



To estimate the risk of lethal strikes to whales in the Channel, we developed a simple, two-dimensional surface model that combined estimates of whale distribution and vessel traffic patterns. Specifically, our model estimated the percent change in the relative risk for each option compared to the relative risk for baseline conditions ("status quo"). To do so, we modeled a change in the speed and/or spatial distribution of vessels, in accordance with each management option, and subsequently calculated the resulting change in both the relative risk of an encounter and the relative risk of a lethal whale strike resulting from each of the four management options. We use both an Average Distribution Model and a Linear Predictive Model to predict the relative distribution of whales in the region. The Average Distribution model assumed whales were evenly distributed throughout the Channel study region, while the Linear Predictive model predicted whale distribution based on bathymetric depth, slope and distance to shore.