

EPA Viewpoint



**Presentation by Mike Samulski
Environmental Protection Agency
to**

**The National Academies of Sciences, Engineering, and Medicine Panel on
“Path Towards Zero Emission Shipping Operations”**

November 8, 2018

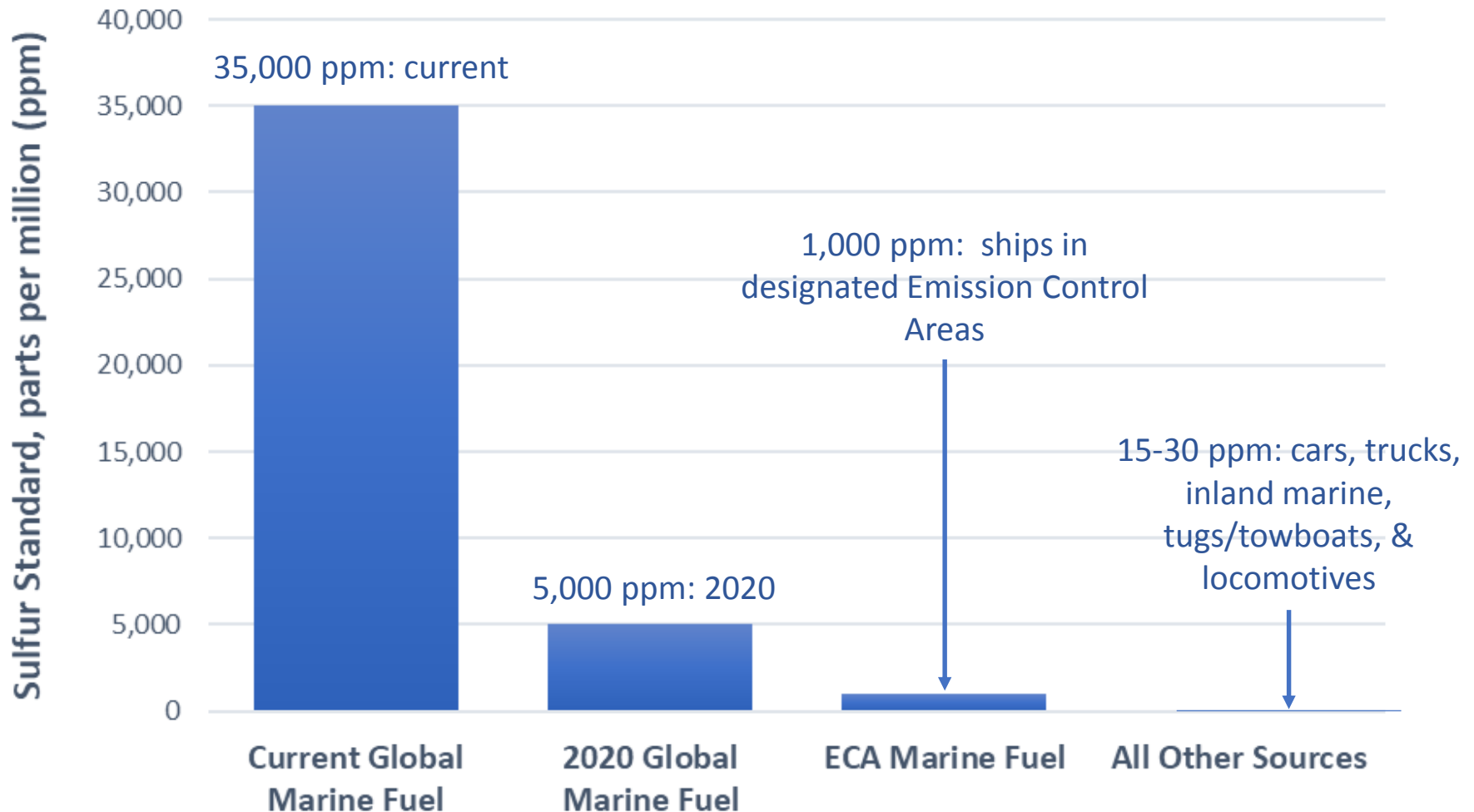
Outline

- Progress in PM and SO_x Reductions: Fuel Sulfur Limits
 - Emission Control Areas
 - Global Sulfur Limit
- Progress in NO_x Reductions: Tier III NO_x Limits

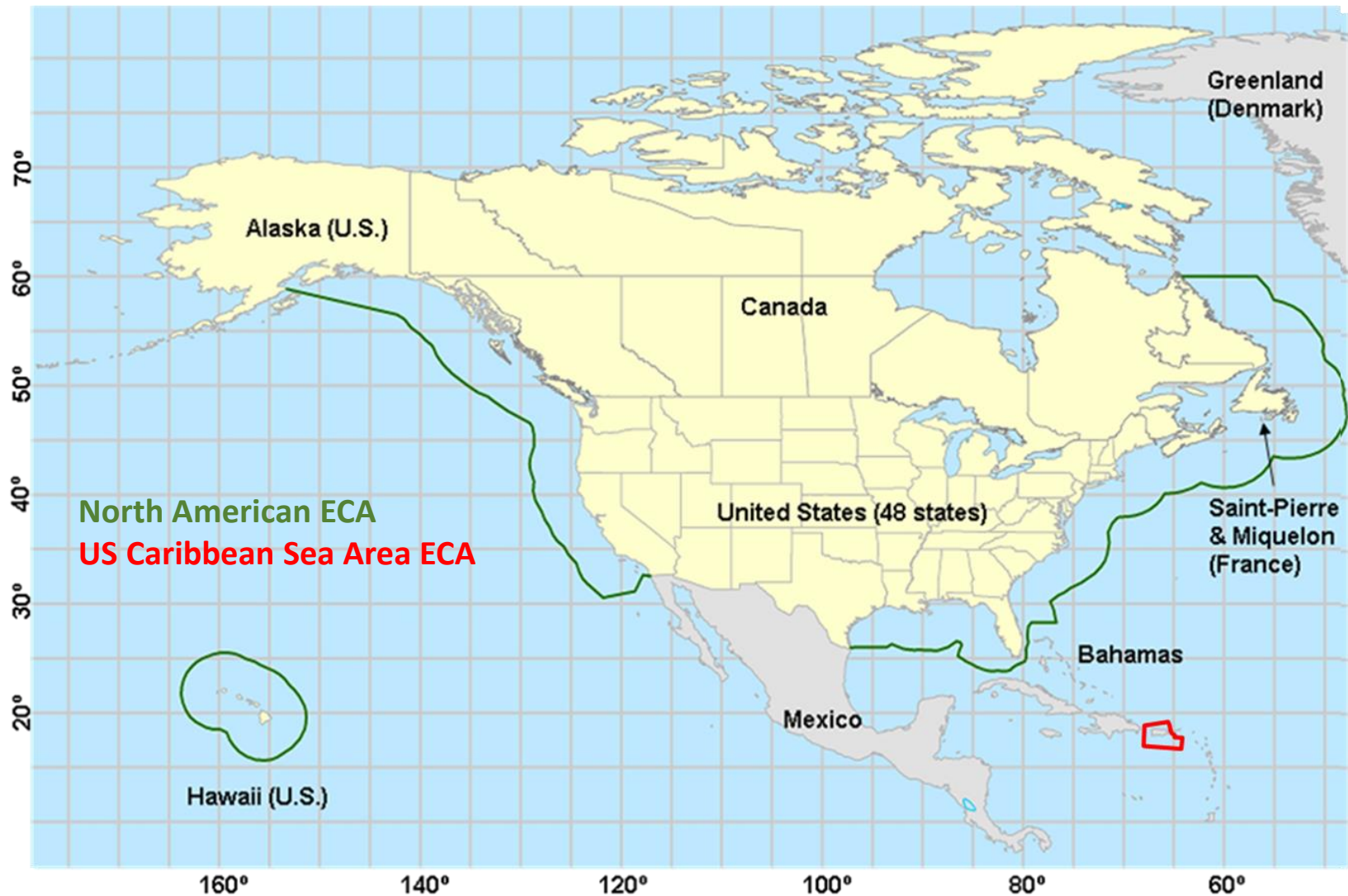


Overview of Fuel Sulfur Standards

- Ship PM and sulfur emissions are addressed through international fuel sulfur limits

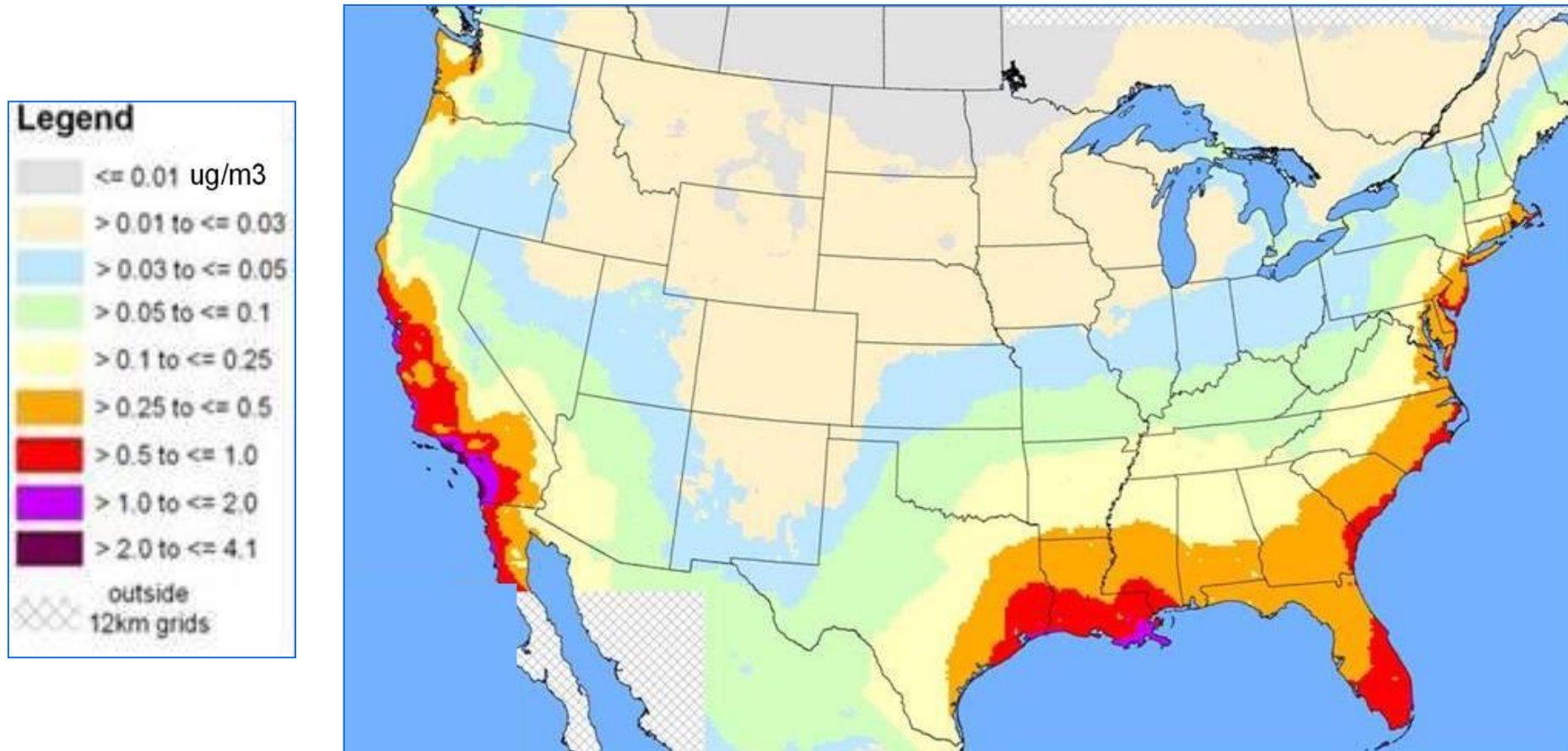


U.S. Emission Control Areas



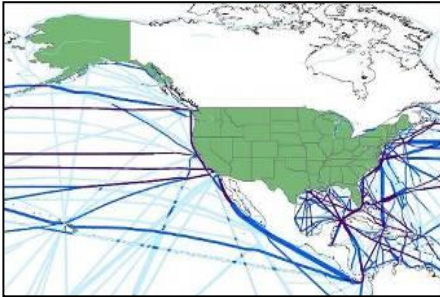
2020 Estimated ECA PM_{2.5} Reductions

- The ECA sulfur limits are having a significant impact on improvements in human health and the environment

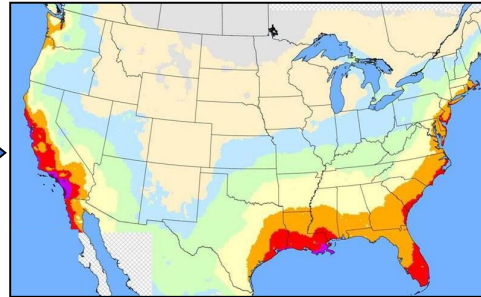


Estimated ECA Impacts

Emissions
Inventory



Air Quality
Modelling



Health Effects
Modelling



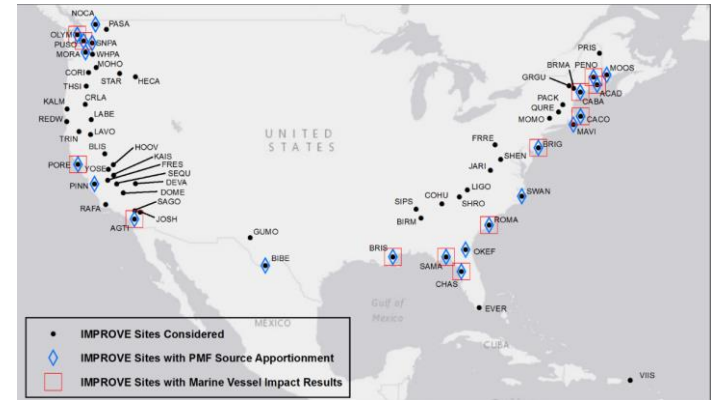
Impacts of U.S. ECA

Impacts (Annual)	2020	2030
Premature deaths prevented	5,000 - 14,000	12,000 - 31,000
Lost work days prevented	720,000	1,400,000
Minor restricted activity days prevented	4,700,000	9,600,000
Program costs (higher fuel costs)	\$1.9 billion	\$3.1 billion
Monetized public health benefits	\$47 - \$110 billion	\$110 - \$270 billion

Actual ECA Emission Improvements

- Recent study examined the effectiveness of the ECA in reducing $PM_{2.5}$
- Based on coastal monitor readings where the unique signatures could be apportioned to ship pollution
- Most sites showed 80% or more reduction in annual average $PM_{2.5}$ from ships

Kotchenruther, R.A., *The effects of marine vessel fuel sulfur regulations on ambient $PM_{2.5}$ at coastal and near coastal monitoring sites in the U.S.*, Atmospheric Environment 151, 52-61, 2017.



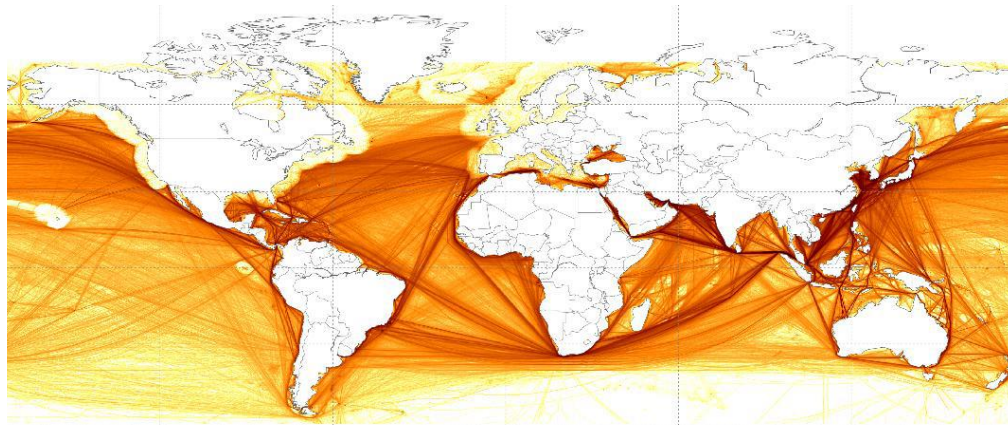
Global Sulfur Cap

- The International Maritime Organization (IMO) established the 2020 global sulfur cap in 2008
- However, under IMO regulations, the global Sulfur Cap was subject to an availability review
 - The review was completed in 2016
 - Concluded that compliant fuel will be available in 2020
- IMO's Marine Environment Protection Committee confirmed the 2020 effective date in October 2016



Expected Benefits of Global Standard

- A 2007 study estimated that shipping-related PM emissions are responsible for approximately 60,000 cardiopulmonary and lung cancer deaths annually, and projected a 40% increase by 2012
- A 2016 follow up study estimated that the global fuel sulfur standard for ships, from 2020 to 2025 alone, will contribute to the prevention of more than 570,000 premature deaths



“Mortality from Ship Emission: A Global Assessment,” Corbett et. al., Environ. Sci. Technolo. 2007, 41, 8512-8518

“Health Impacts Associated with Delay of MARPOL Global Sulphur Standards,” Corbett et. al. Finnish Meteorological Institute, 2016

Transition to Global Standard

- In recent months, trade articles and studies have raised concerns about the potential market impacts of global sulfur cap
 - Short term increases in distillate price
 - Shipping industry concerns about consistent availability/quality
- The market is expected to respond to price changes though
 - Distillate supply increased through refinery upgrades
 - Decreased distillate demand from ships (e.g. scrubbers, LNG)



Recent IMO Action

- Actions under way to promote smooth implementation of the 2020 global sulfur cap

Amendment to Annex VI to prohibit carriage of HFO for use as fuel onboard unless the ship is equipped with a scrubber or other approved equivalent technology – Adopted at MEPC 73

Developing an enhanced fuel non-availability reporting system with central reporting (to IMO)

Guidance for ship implementation plans to help transition to the 2020 standards – Approved at MEPC 73

Guidance for best practices for fuel purchasers and suppliers – Approved at MEPC 73

The Committee invited further proposals to enhance implementation with respect to fuel oil quality and reporting of non-availability of compliant fuel oils, for data collection and analysis

SOx Scrubber Development



- When the ECA first went into place, there was little experience with this alternative SOx reduction technology on ships
- USCG and EPA worked on scrubber technology development programs with six shipping companies
 - Successful installation on ~60 ships
 - Different ship types and scrubber designs
- DNV-GL reports there are now 1850 ships with installed or confirmed scrubber installations

LNG Vessels

- Liquefied natural gas (LNG) has near zero sulfur
- Engines operating on LNG can comply with Tier III NOx standards as well
- Globally, there are more than 200 LNG powered ships either in operation or on order
- SOLAS has been revised to accommodate LNG technology (IGF code – 1/1/2017)
- Growth in LNG use is tied to the development of a bunkering infrastructure
 - LNG ships currently fueled by truck or bunker barge
 - A port-side refueling facility is under construction in Tacoma



Tier III NOx Engines

- IMO Tier III NOx standards require an 80% NOx reduction below Tier I
 - Expected to be met with Selective Catalytic Reduction (SCR), Exhaust Gas Recirculation (EGR), or LNG
 - For the North American and U.S. Caribbean Sea ECAs, Tier III applies to ships built beginning in 2016
 - For Baltic and North Sea ECAs, not until 2021
- USA experience: little turnover to Tier III ships
 - Tier III applies to new ships
 - Delay in anticipated NOx reductions



SCR Experience on Ships

- Installed in more than 500 ships over the past 20 years
- Operation on some ships >10 years and 80,000 hours
- Wide range of engine sizes and ship applications
- New ships and retrofits on existing ships



For Further Information

Regulations for Emissions from Marine Vessels

<https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-emissions-marine-vessels>



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