Workshop for a Study on the Impacts of Compliance with the ECA Fuel Sulfur Limits on U.S. Coastal Shipping

July 30, 2018

U.S. Environmental Protection Agency

Washington, DC

Agenda

- Overview
- The North American ECA
- The Great Lakes Study (2012)
- This Coastal Shipping Study
- Request for Stakeholder Support
- Timeline and Next Steps

Overview

- Consolidated Appropriations Act, 2017 (Pub. L. 115-31)
  - Joint Explanatory Statement → 2016 Senate Appropriations Committee Report

- 2016 Senate Appropriations Committee Report (Pub. L. 114-281)
  - Committee concern: ECA fuel sulfur requirements could lead to transportation mode shift, increased emissions
  - Consider exempting vessels with engines below 32,000 horsepower and that operate more than 50 miles from shore

Overview

- EPA Report to Congress, February 2018
  - Need to study transportation mode shift in coastal marine transportation sector
    - Use approach similar to the 2012 Great Lakes study
    - Stakeholder input will be important!
- This study is the first step
  - If there is a risk of modal shift in the coastal marine transportation sector, would the exemption described by Congress address that risk?
  - If so, what would be the environmental impacts of the exemption described by Congress?

Purpose of This Workshop

- Provide background about the North American ECA and the 2012 Great Lakes study
- Describe the analytic methodology we are planning to use
- Request your support with respect to routes studies and data used

Purpose of This Workshop

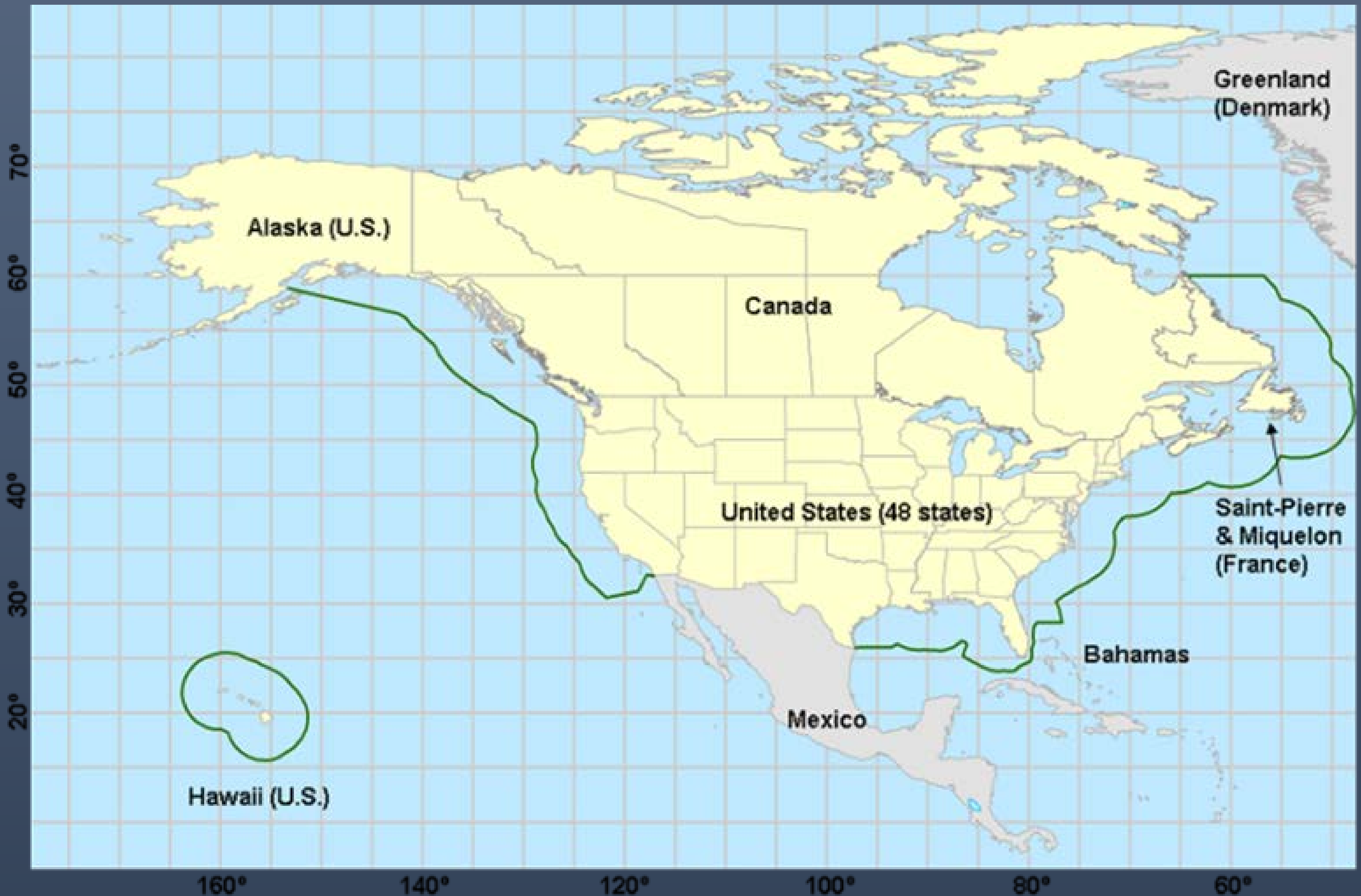
- This workshop and the study are <u>not</u> about reconsidering or revisiting the North American ECA
- The ECA delivers significant benefits to U.S. air quality, human health and environmental protection, and is expected to remain the centerpiece of our coordinated strategy to reduce emissions from large ships
- Benefits extend hundreds of miles inland, will help States attain and maintain the PM NAAQS

The North American ECA

North American ECA

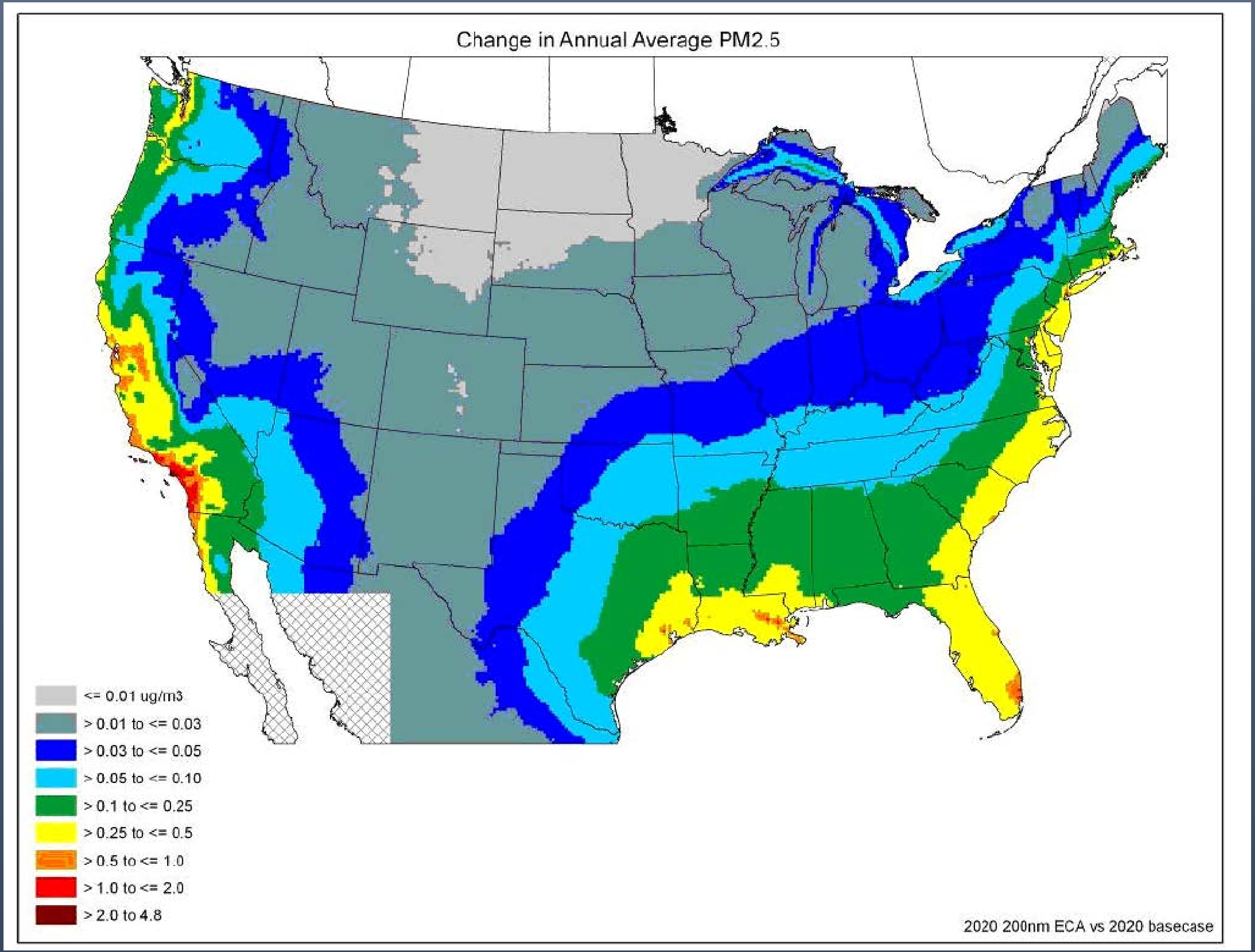
- Emission Control Areas --
  - Designated by amendment to MARPOL Annex VI
  - Fuel sulfur limit 1,000 ppm, began 1/1/15
    - Global fuel sulfur cap: 35,000 ppm; 5,000 ppm beginning 2020
    - Nonroad diesel fuel: 15 ppm
- North American ECA --
  - July 2009: Approved by IMO's Marine Environment Protection Committee
  - March 2010: Annex VI amendment adopted
  - February 2011: Annex VI amendment accepted
    - August 2011: Entry into force
  - August 2012: North American ECA begins

North American ECA



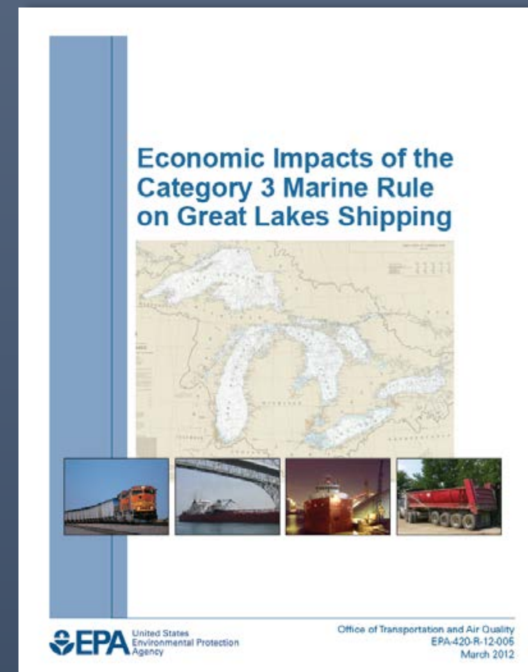
North American ECA

- ECA Proposal: comprehensive environmental and economic analysis, state-of-the-art science, peer reviewed methods
- By 2020, annual benefits as much as $110 Billion per year
  - Annual PM and SOx emissions decrease: 74% and 86%
  - Prevent as many as 14,000 premature deaths annually
  - Respiratory symptoms reduced for nearly 5 million people each year
  - Other, non-monetized health-related benefits as well
- Annual costs: about $3.2 billion per year



Virtually every state will see air quality improvements

2012 Great Lakes Study



Great Lakes Study (2012)

- Conference Report to H.R. 2996 (111-316)
  - Congress concerned about the impacts of applying the ECA fuel sulfur limits on the Great Lakes
  - EPA should perform a study to evaluate the economic impact of the final rule on Great Lakes Carriers
- Collaborative effort: EPA requested and received Great Lakes shipping industry assistance for the analysis

Great Lakes Study

- 3- part study:
  - Transportation mode shift: shift transportation mode
  - Source shift: shift suppliers
  - Production shift: shift production locations
- Examined specific, at-risk Origin/Destination Pairs
  - At-risk: competition between marine and land transportation of concern
  - If no shift found for these at-risk O/D pairs, then no shift expected for other routes without such market pressures
- The study was peer-reviewed by industry experts

Great Lakes Study

- Stakeholders provided key assistance
  - Identified candidate at-risk O/D pairs
  - Specified ship characteristics, route constraints for the O/D pairs selected for study
- Stakeholders know their industry better than we do!

Transportation Mode Shift Analysis

- Would an increase in marine fuel costs cause users to shift to less efficient land-based transportation modes?

Great Lakes Study

Geospatial modeling and freight rate analysis

U.S. Environmental Protection Agency
Stakeholder Meeting

Washington, DC
July 30, 2018

James J. Corbett, PhD, PE
James J. Winebrake, PhD
Edward W. Carr, PhD

Analysis of Great Lakes Scenarios

Great Lakes Shipping Cost Model: Overview

- Scope
  - Estimate costs of shipping for selected O-D pairs and vessels
  - Estimate the impact of compliant fuel on shipping freight rates for selected routes
  - Identify practical all-land alternative(s)
  - Estimate shipping costs of using identified alternative land-based routes
- Approach
  - Geospatial modeling
  - Freight rate analysis
  - Comparison of the adjusted marine freight rate to the all-land alternative

Iron Ore: Hull Rust Mine, MN to Gary, IN

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	Intermodal Route	Unimodal Rail Route
Total Vessel Distance (miles)	870	
Total Rail Distance (miles)	80	
Total Route Distance (miles)	950	570
Tons Transported (net ton)	48,620	48,620
Base Scenario Fuel Costs ($/cargo ton)	$2.24	
MDO Scenario Fuel Costs ($/cargo ton)	$3.16	
Change in Fuel Costs ($/cargo ton)	$0.93	
Total Transfer Cost ($/cargo ton)	$1.35	$1.25
Total Vessel Portion of Freight Rate for Base Case ($/cargo ton)	$3.34	
Total Rail Portion of Freight Rate ($/cargo ton)	$1.52	$10.74
Total Freight Rate for Base Case ($/cargo ton)	$6.21	$11.99
Total Freight Rate for MDO Case ($/cargo ton)	**$7.14**	

Coal: Rosebud Mine, MT to Essexville MI

Coal: Rosebud Mine, MT to Essexville, MI

	Intermodal Route	Unimodal Rail Route
Total Vessel Distance (miles)	620	
Total Rail Distance (miles)	1,040	
Total Route Distance (miles)	1,660	1,660
Tons Transported (net ton)	28,290	28,290
Base Scenario Fuel Costs ($/cargo ton)	$2.78	
MDO Scenario Fuel Costs ($/cargo ton)	$3.91	
Change in Fuel Costs ($/cargo ton)	$1.13	
Total Transfer Cost ($/cargo ton)	$1.55	$1.50
Total Vessel Portion of Freight Rate for Base Case ($/cargo ton)	$7.11	
Total Rail Portion of Freight Rate ($/cargo ton)	$16.62	$26.62
Total Freight Rate for Base Case ($/cargo ton)	$25.28	$28.12
Total Freight Rate for MDO Case ($/cargo ton)	$26.41	

Coal: Rosebud Mine, MT to Essexville, MI

- Coal transportation from Minehead at Rosebud, MT to Essexville, MI
- Length and draft restrictions encountered
  - Welland Canal: 740 feet
  - Dock length: ≤ 1000 feet
  - Draft: 23 feet
- Assumed vessel cargo load

$$Assumed\ Cargo\ Load = C_{vessel} - TL * (D_{max} - D_{assumed})$$

C_{vessel} = Vessel cargo capacity in net tons, using adjustments described in Table 10

D_{max} = Vessel draft at maximum cargo load in feet

$D_{assumed}$ = Vessel draft considering constrained port or channel conditions in feet

TL = Tons of vessel cargo capacity lost per foot of draft reduction in net tons per foot

Methodology Summary

1. Identify selected O-D pairs
2. Identify appropriate vessel type and practical alternative land-based routes for given cargo and capacity
3. Identify navigation restrictions (if any)
4. Main and auxiliary engine horsepower and fuel consumption
5. Identify example cargo load
6. Model port to port vessel route distance
7. Model alternative land route distance
8. Estimate the impact of compliant fuel on marine freight rates
9. Estimate and compare adjusted marine freight rates to all-land alternative

Methodology Validated through Peer Review

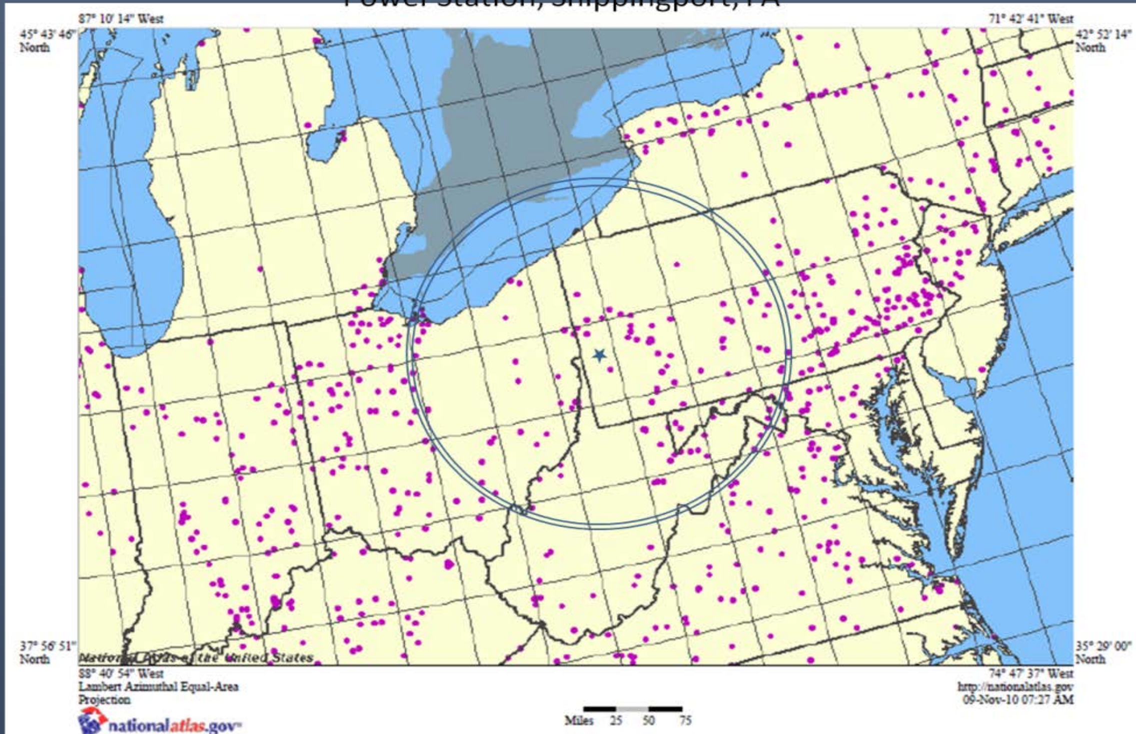
- Study underwent extensive peer review process
- Three expert reviewers confirmed that this methodology represented a comprehensive approach this question

Source Shift Analysis

- Would an increase in marine fuel costs lead users to shift purchases to local stone quarries?
- Methodology: Competitive Radius analysis
  - Truck transportation costs for quarries within that area is about the same as marine transportation costs for stone from the distant source currently used
  - Adjust the competitive radius to reflect ECA compliance costs
  - Would the change affect market competition?
- Results:
  - Only a small increase in the competitive radius for each facility
  - No source shift indicated

Example: Source Shift

Scenario 16: Bruce Mansfield
Power Station, Shippingport, PA



One shipload = 974 42-ton trucks
(41,900 tons stone)

Production Shift Analysis

- Would electrical generation or steel production move out of the area due to ECA compliance costs?

- Methodology: two-part retail revenue analysis
  - Estimate the increased transportation costs as a percentage of revenues for the relevant market
  - Compare to historic price fluctuations for steel, electricity

- Results:
  - Percentage increase is within historic price fluctuations for steel and for electricity

Coastal Shipping Study

What is “Coastal” Shipping?

- Transportation of goods or materials by ship along the coasts
  - Originating port located in United States, Canada, Mexico, or Central America
  - Destination port located on the U.S. Pacific, Atlantic, or Gulf coasts (not Great Lakes)
  - … or vice versa!
- There is a land-based alternative route
  - Truck or rail
  - Pipeline?

Coastal Shipping Methodology

U.S. Environmental Protection Agency Stakeholder Meeting

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The Modeling Framework

Framing the Question

- Examining the impacts of complying with ECA fuel requirements on the costs of coastal goods movement requires understanding:
  - Costs involved in coastal shipping
  - Cost component due to fuel expenditures
  - Anticipated changes in costs due to increased fuel prices
  - Cargo-specific cost basis (for comparison with land route alternative)
  - Cost of cargo units by all land alternative

Analytical Approach

Characterize coastal vessels and routes

Develop cost functions for coastal shipping

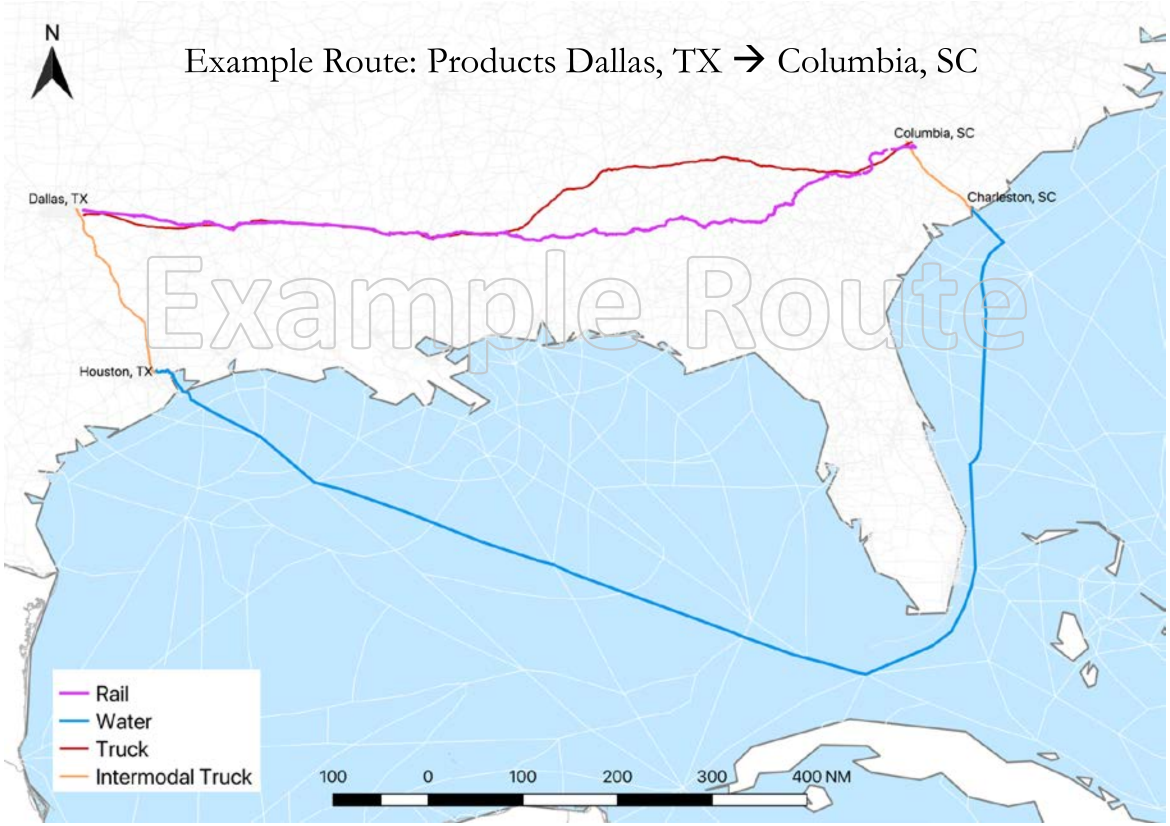
Estimate fuels cost component for vessels

Estimate freight costs for shipping and alternative land-based routes (for base fuel price, estimated new price, and cargo)

Examine a scenario with the increased shipping freight rate; compare adjusted freight rates

Scenario Construction

- Scenario construction involves
  - Common cargo patterns and coastal transport routes
  - Commonly transported commodities and cargo
  - Characteristics of vessels identified as traveling key routes and cargo
  - Other factors that the industry sees as important and relevant



Coastal Shipping Cost Model: Elements

- **Voyage costs** are the variable costs of a vessel trip:
  - Fuel costs for main (FM) and auxiliary engine (FA)
  - Port fees (P)
  - Canal dues (CD)
  - Tug fees (T)
- **Operational costs** are ongoing costs of vessel operation
  - Personnel/labor (L)
  - Repairs (R)
  - Stores (consumable supplies) (S)
  - Maintenance (M)
  - Insurance (I)
- **Capital costs** of financing vessel equipment
  - Capital payments(CP)
  - Interest payments (IP)
- **Cargo handling costs (CS)** are charges including:
  - Cargo loading charges (LC)
  - Cargo discharge costs (DC)
  - Cargo claims (CL)
- **Periodic maintenance (PM)** is required every several years by federal and international regulations

Coastal Shipping Cost Model

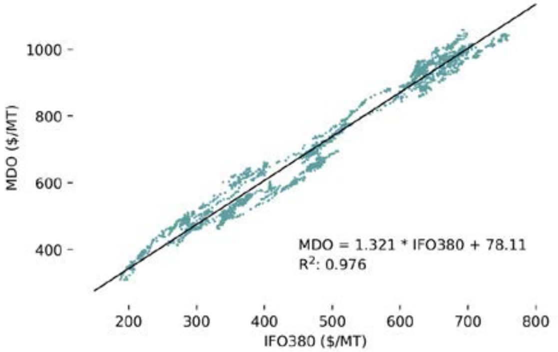
- EERA Coastal Shipping Cost Model also incorporates:
  - Data specific to Coastal region
    - Harbor Maintenance Tax
    - Port and cargo-handling fees
  - Data representative of coastal vessels
    - Engine size, service speed, cargo capacity, age, unloading time
    - Ability to include/exclude capital costs

Coastal Shipping Details

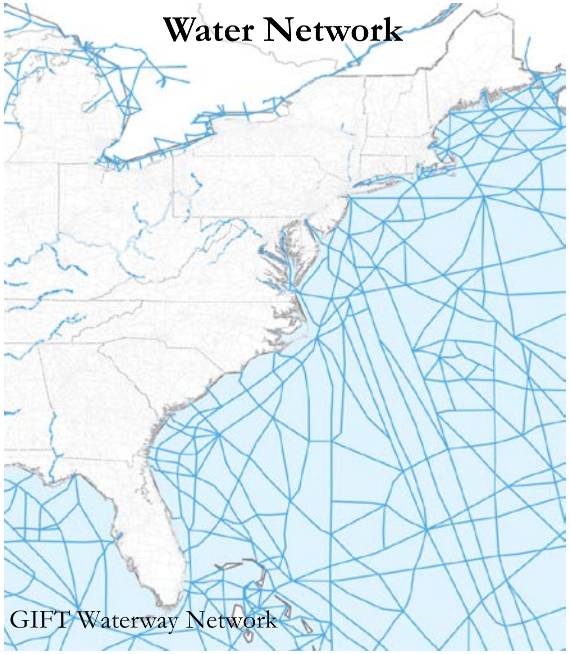
- Routes include to/from Canada and Mexico as well as US Port to Port
- 2016 US Army Corps of Engineers Entrances and Clearances data (foreign cargo movements to/from US)
  - 5653 trips to/from Canada
  - 8689 trips to/from Mexico
- Jones Act ships (US flag/built/crew) must be used to transport cargo/material/petroleum products from one US port to another (~1300 ships)
  - 92% of Non-military Jones Act Ships are Category 1 or 2 required to use ULSD
  - 92% are Tugs that push barges

Coastal Shipping Cost Model: Fuel

- Fuel consumption model incorporates
  - Specific fuel oil consumption (g/kWh)
    - Main and auxiliary engines
    - Age
    - Engine power and load
    - Engine type
  - Speed and voyage duration
  - Cargo moved
    - Fuel consumption per ton-mile
  - Range of fuel prices
    - Spot price or 10-year average



We Integrate Three Independent Networks

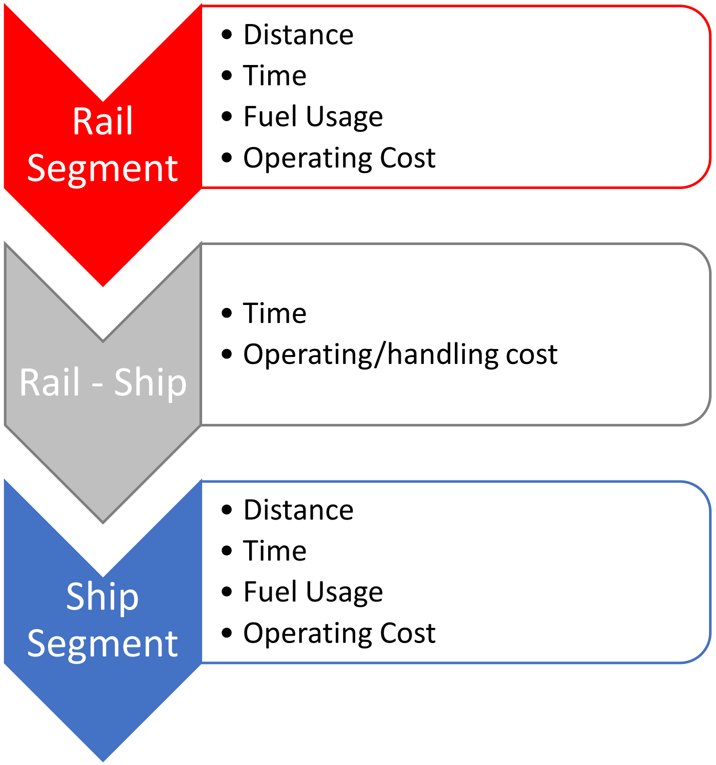


Intermodal Freight Routing Model

- GIFT was jointly developed by the Rochester Institute of Technology and the University of Delaware
  - With support from US DOT/MARAD, Great Lakes Maritime Research Institute, ARB and others
- Intermodal freight routing tool that
  - Evaluates the *economic, energy, and environmental* costs of freight transport
  - Analyzes tradeoffs across multi-modal freight transport routes
  - Examines impacts of freight transport policies
  - Calculates optimal routing of freight between origin-destination points
  - Can solve for least-time, least-emissions, least-cost objectives

Methodology: Attributes and Evaluators

- Network solves for least-distance routes
- Time, distance and costs associated with each modal network feature
  - Water
  - Rail
  - Road
- Intermodal transfer facilities
  - Time
  - Costs



Recap/Summary of Methodology

- Intermodal Modeling Methodology:
  - Run a scenario based on published freight rates for ship and for rail
  - Adjust the ship freight rates to include higher fuel costs
  - Run a scenario with the new ship freight rate
  - Compare costs across alternate land route(s)
- Cost Model Methodology:
  - Estimate the portion of total voyage costs devoted to fuel (from Coastal Shipping Cost Model)
  - Estimate whether fuel price differentials can affect the pressure on marine freight rates compared to practical all land alternatives
- This decision support product will be similar to what EPA was able to use for the Great Lakes Study, applying a similar methodology

Request for Stakeholder Support – Data inputs

Which O/D Pairs to Study?

- You know your industry better than we do!
- Which O/D pairs should we include in the analysis?
  - Locations on West, East, Gulf coasts
  - What cargo?
  - What ships?
- Should the study also include --
  - Source shift analysis?
  - Production shift analysis?

Data Needs

- For each O/D pair:
  - The types of ships that operate on these routes
  - The engines on those ships and type of fuel they use
  - Type and amount of cargo per ship
  - Characteristics of the routes (e.g., port depth limits)
  - Freight rates
- EPA protects Confidential Business Information!

Next Steps and Timeline

Timeline

- Next Steps
  - You propose candidate O/D pairs
  - We will share the candidate list – is it comprehensive?
  - We will select the O/D pairs to study
- Timeline:
  - December 2018: complete Mode Shift analysis
  - July 2019: complete report
  - December 2019: complete peer review
  - September 2020: submit to Congress

Thank you!

- Our North American ECA website has links to the Great Lakes Report and this Workshop website
  - https://www.epa.gov/regulations-emissions-vehicles-and-engines/designation-north-american-emission-control-area-marine#Great-lakes
- Additional questions or comments?
  - Revelt.jean-marie@epa.gov