Category 1 / Category 2 Vessel Port Underway Split for 2011 National Emission Inventory

U.S. EPA Emission Inventory Conference, San Diego, CA
April 12 - 16, 2015

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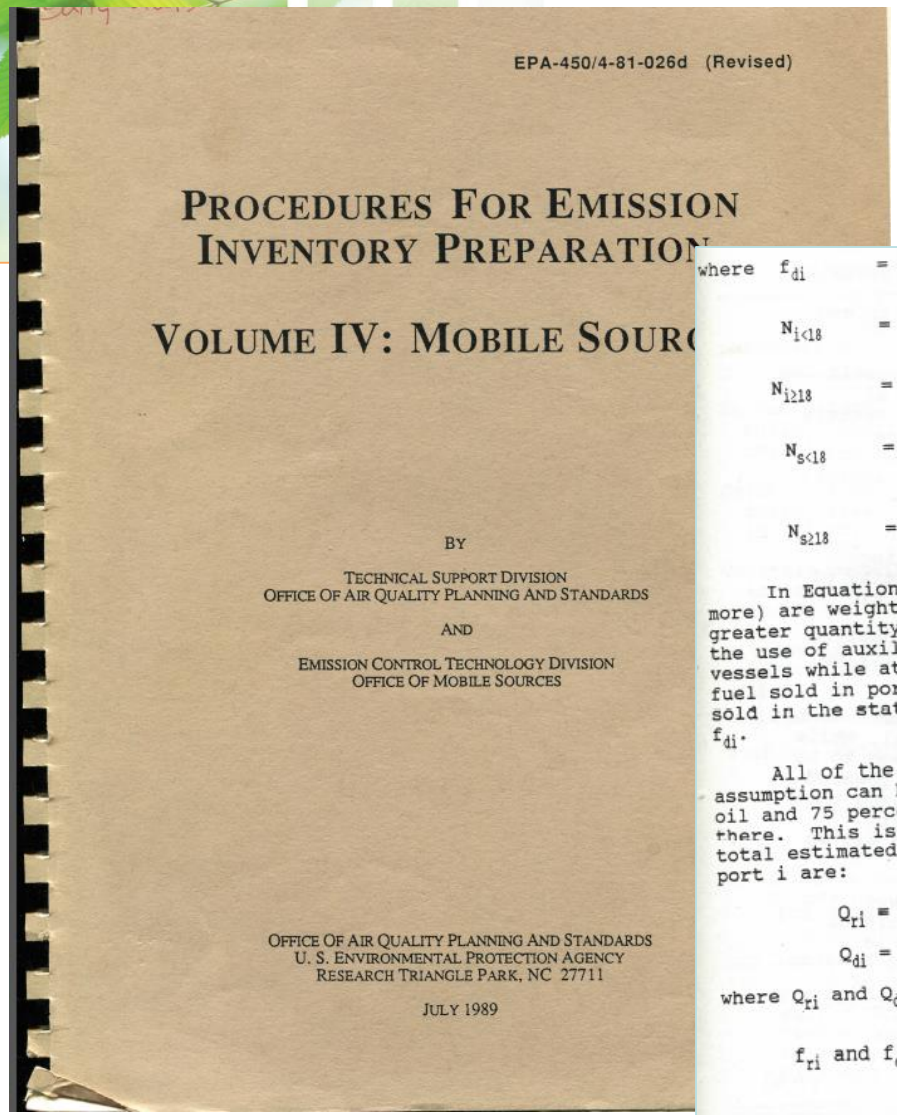
Introduction



EPA-450/4-81-026d (Revised)

PROCEDURES FOR EMISSION INVENTORY PREPARATION

VOLUME IV: MOBILE SOURC

BY

TECHNICAL SUPPORT DIVISION
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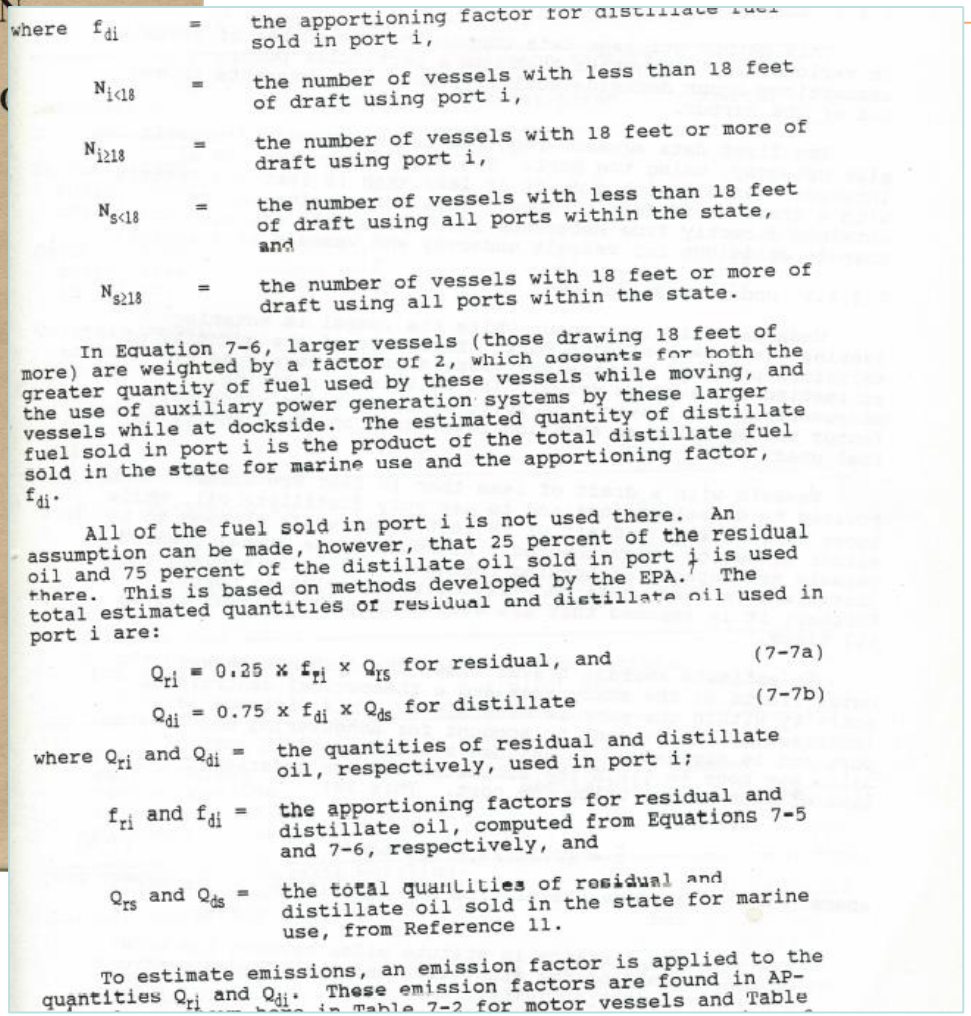
JULY 1989



where f_{di} = the apportioning factor for distillate fuel sold in port i,

$N_{i<18}$ = the number of vessels with less than 18 feet of draft using port i,

$N_{i\geq18}$ = the number of vessels with 18 feet or more of draft using port i,

$N_{s<18}$ = the number of vessels with less than 18 feet of draft using all ports within the state, and

$N_{s\geq18}$ = the number of vessels with 18 feet or more of draft using all ports within the state.

In Equation 7-6, larger vessels (those drawing 18 feet of more) are weighted by a factor of 2, which accounts for both the greater quantity of fuel used by these vessels while moving, and the use of auxiliary power generation systems by these larger vessels while at dockside. The estimated quantity of distillate fuel sold in port i is the product of the total distillate fuel sold in the state for marine use and the apportioning factor, f_{di}.

All of the fuel sold in port i is not used there. An assumption can be made, however, that 25 percent of the residual oil and 75 percent of the distillate oil sold in port i is used there. This is based on methods developed by the EPA.[7] The total estimated quantities of residual and distillate oil used in port i are:

$$Q_{ri} = 0.25 \times f_{ri} \times Q_{rs} \quad \text{for residual, and} \qquad (7\text{-}7a)$$

$$Q_{di} = 0.75 \times f_{di} \times Q_{ds} \quad \text{for distillate} \qquad (7\text{-}7b)$$

where Q_{ri} and Q_{di} = the quantities of residual and distillate oil, respectively, used in port i;

f_{ri} and f_{di} = the apportioning factors for residual and distillate oil, computed from Equations 7-5 and 7-6, respectively, and

Q_{rs} and Q_{ds} = the total quantities of residual and distillate oil sold in the state for marine use, from Reference 11.

To estimate emissions, an emission factor is applied to the quantities Q_{ri} and Q_{di}. These emission factors are found in AP- in Table 7-2 for motor vessels and Table

Category 1/2 Census

CATEGORY 2 VESSEL CENSUS, ACTIVITY, AND SPATIAL ALLOCATION ASSESSMENT AND CATEGORY 1 AND CATEGORY 2 IN-PORT/AT-SEA SPLITS

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February 16, 2007

C1/C2 Vessel Categories / Data Source

Vessel Type	Vessel Characteristics	Activity	Spatial elements
Tugboats	American Waterways Operators U.S. Coast Guard Merchant Vessels of the U.S. U.S. ACE Waterborne Transportation Lines of the U.S. Inland River Record IHS Registry of Ships American Bureau of Shipping	American Waterways Operators U.S. ACE Waterborne Commerce. U.S. Coast Guard Vessel Movement Database	BTS Transportation Atlas U.S. ACE Waterborne Commerce. U.S. ACE Waterborne Transportation Lines of the U.S. U.S. ACE Waterway Link Commodity Data
Commercial Fishing	U.S. Coast Guard Merchant Vessels of the U.S. California Commercial fishing Data Alaska CFEC permits Washington Department of Fish and Wildlife.	NOAA, National Marine Fisheries Service	NOAA, National Marine Fisheries Service
Coast Guard	U.S. Coast Guard Website		U.S. Coast Guard Website
Ferries	Inland River Record American Bureau of Shipping	American Public Transportation Association, Public Transportation Fact book	BTS National Ferry Data base
Small deepwater cargo vessels	IHS Register of Ships American Bureau of Shipping	U.S. ACE Vessel Clearance and Entrance Data U.S. Coast Guard Vessel Movement Database	BTS Transportation Atlas U.S. ACE Waterway Link Commodity Data
Offshore support vessels	Offshore Marine Service Association Rig zone U.S. Coast Guard Merchant Vessels of the U.S. Offshore Support Vessels of the World.	BOEM Gulf of Mexico emission inventory Workboat (publication)	BOEM Gulf of Mexico emission inventory EPA 2011 NEI data file
Great Lake Vessels	IHS Register of Ships American Bureau of Shipping	U.S. ACE Vessel Clearance and Entrance Data U.S. Coast Guard Vessel Movement Database	BTS Transportation Atlas U.S. ACE Waterway Link Commodity Data
Research Vessels	IHS Register of Ships American Bureau of Shipping	University of Delaware database of Research vessels University- National Laboratory System Ocean Physics Laboratory	University of Delaware database of Research vessels University- National Laboratory System

General Approach
Data Compilation / Activity Estimation

$$Thp\text{-}hr_{ij} = VP_i \times UR_i \times EN_i \times HP_{ij} \times DO_{ij} \times 24 \times LF_{ij}$$

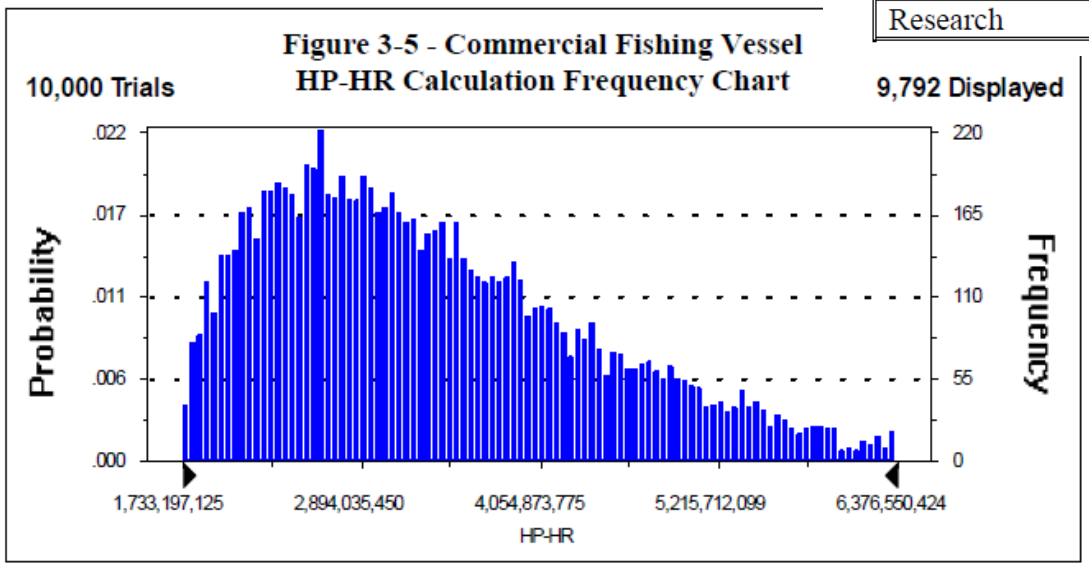
Where:

$Thp\text{-}hr_{ij}$	=	Total horsepower hours for vessel type i in mode j
VP_i	=	Population of vessel type i
UR_i	=	Utilization rate for vessel fleet i
EN_i	=	Average number of engines on vessel type i
HP_{ij}	=	Horsepower of vessel type i
DO_{ij}	=	Days of operation for vessel type i in mode j
24	=	Hours per day
LF_{ij}	=	Load factor of vessel type i propulsion engines in mode j
i	=	Vessel type (i.e., deep water, tow, ferries commercial fishing, Great Lakes, Coast Guard, offshore support, and research)
J	=	Mode of operation (i.e, underway cruise, underway idle)

Variance / Uncertainty

Table 1-3. Category 2 Propulsion Horsepower Hours by Vessel Type

Vessel Type	Mean Values (million hp-hrs)	Standard Deviation (million hp-hrs)
Deep Water	2,666	698
Towboat	7,920	3,020
Ferry	1,464	443
Fishing	3,413	1,143
Great Lakes	1,393	405
Coast Guard	1,441	496
Offshore	27,810	11,933
Research	654	217

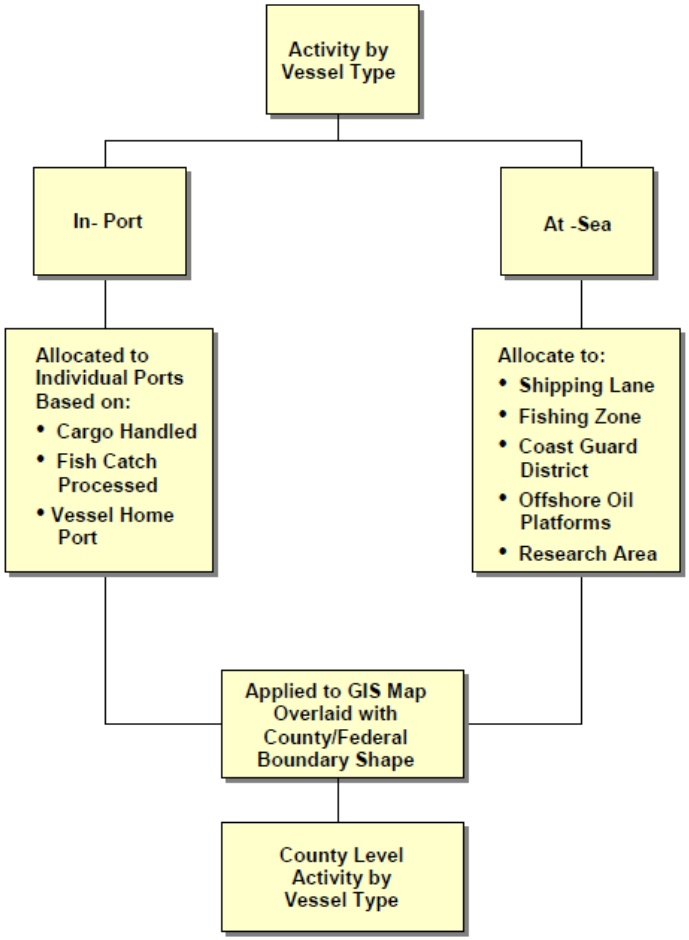


Port/Underway splits

Table 1-4. Average In-Port and At-Sea Fraction by Vessel Type for Vessels Equipped with 2 Propulsion Engines

Vessel Type	In-Port	At-Sea
Towboats	17%	83%
Fishing	5%	95%
Offshore	4%	96%
Ferries	65%	35%
Deepwater	1%	99%
Research	1%	99%
Great Lakes	1%	99%
Government	59%	41%
Weighted Average	**10%**	**90%**

General Approach Spatial Allocations



Example of Spatial Allocations

Figure B-1. Tug/Towboat In-Port Activity

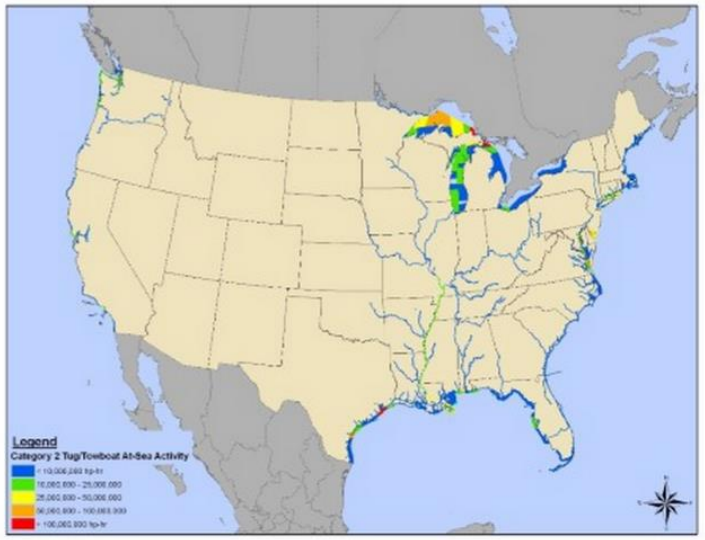
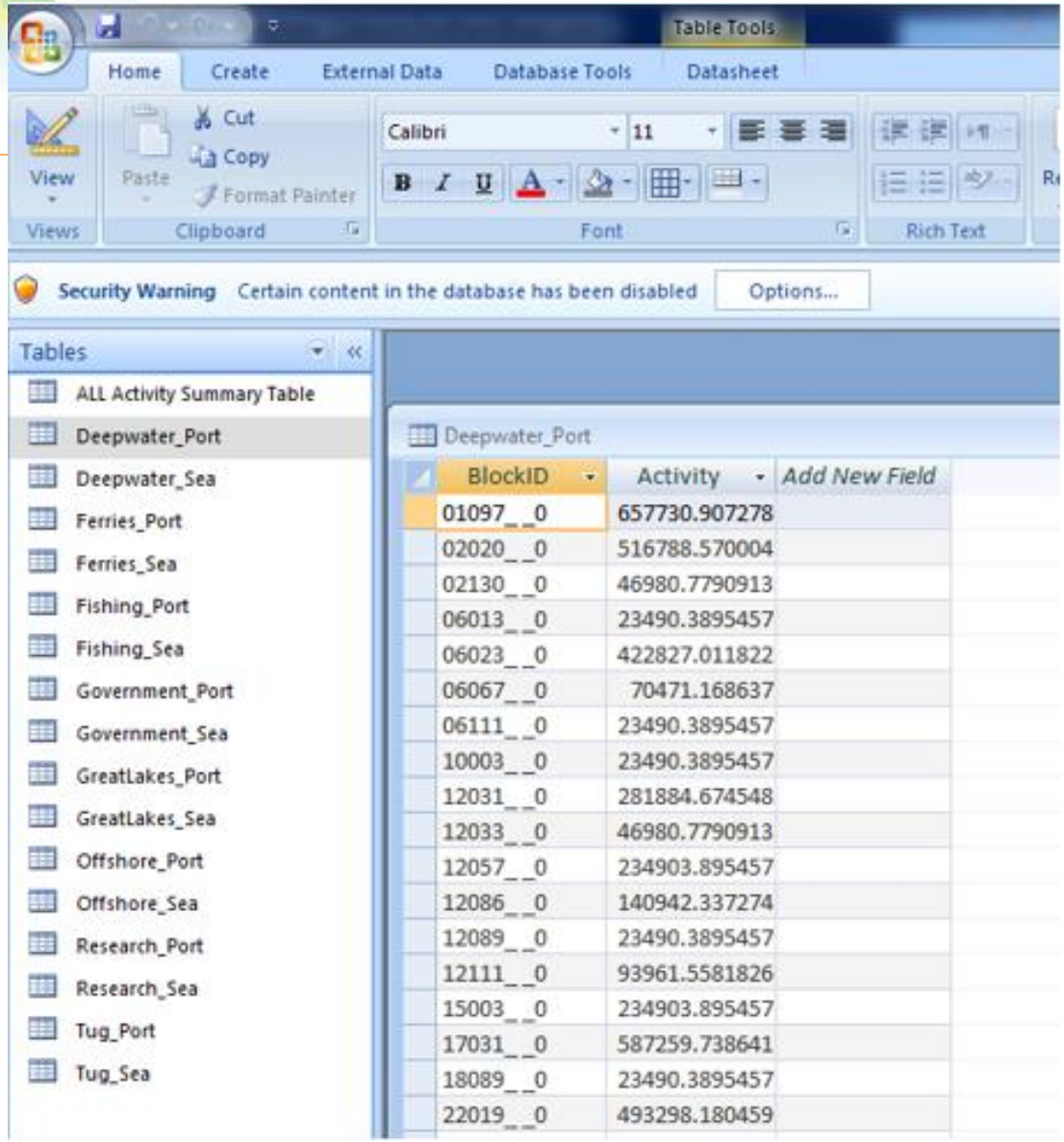


Figure B-2. Tug/Towboat At-Sea Activity

Data Generated



2011 Summary Results

Vessel Type	% of Port Activity	% of Sea Activity
Deepwater	0.0791%	7.8333%
Ferries	2.8246%	1.5210%
Fishing	0.5064%	9.6219%
Government	2.5239%	1.7539%
GreatLake	0.0413%	4.0934%
Support (Offshore & Research)	1.7766%	43.9192%
Tugs	3.9959%	19.5094%
Total	**11.7479%**	**88.2521%**

The activity for port and underway operations for all C1/C2 vessel types were aggregated and used as a weight factor for each allocation block and vessel operations using the following equation:

$$SA_{iJ} = A_{iJ}/\sum A_{iJ}$$

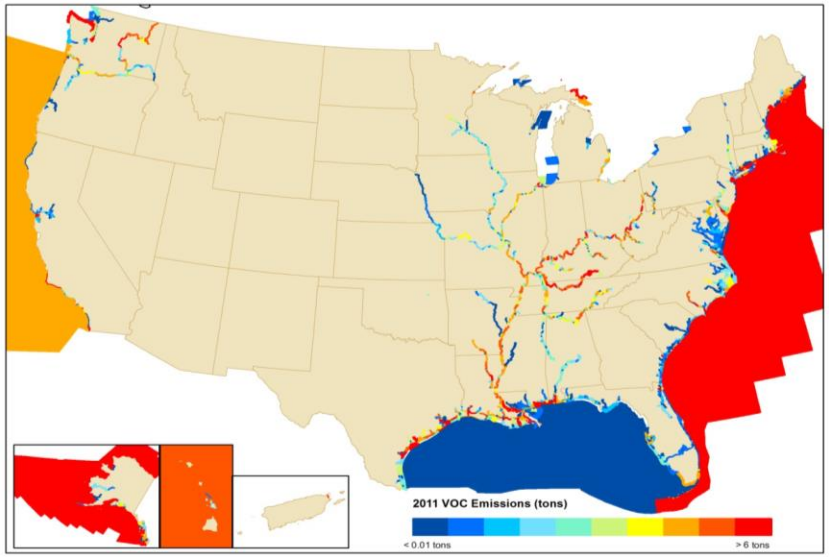
Where:

SA_{iJ} = Spatial activity factor for vessel type *i* operating in block *J*

A_{iJ} = Census Report activity for vessel type i in block J

i = Vessel type (e.g., tug, ferry, fishing) and operation (i.e., port, underway)

J = Specific spatial block



Improvements

- Disaggregation of Port of Southern Louisiana and Baton Rouge port emissions to include extended boundaries of the ports

- Disaggregation of CT and MA ferry activities to all ports that reported ferry traffic in BTS' National Census of Ferry Operators

- Reviewed tug data to check high activity in the Ohio River area

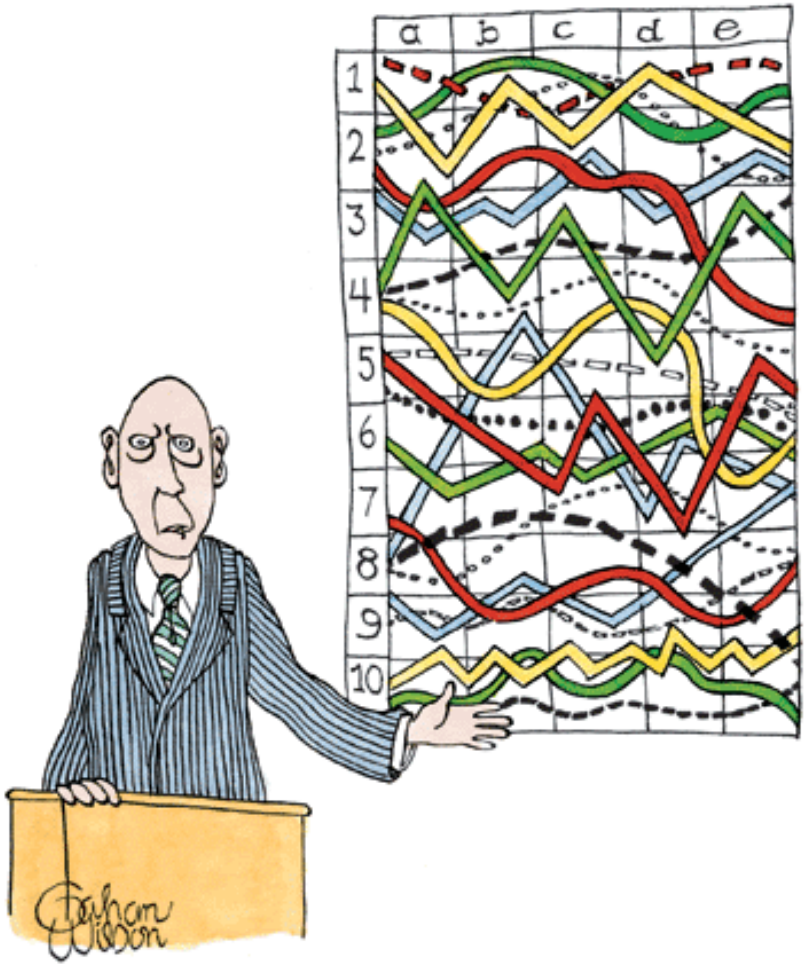
Conclusions....

- Use of the C1/C2 census data allowed for a better approximation of port and underway activities
- Allowed activity to be developed for different vessels categories
- Planning to update the C1/C2 census data and apply the kw-hrs to emission factors to get 2014 emissions for NEI.

Acknowledgments

- **EPA staff that supported this effort,**
  - Laurel Driver
  - Penny Carey
  - Brian Timin
- **Staff who work on the original C1/C2 report**
  - Dr. James Corbett
  - Sam Wells
  - Guiselle Aldrete
- **Staff who helped with the 2011 CMV NEI**
  - Roger Chang
  - Heather Perez
  - Jennifer Sellers

Questions?



"I'll pause for a moment so you can let this information sink in."