Nine Ports in the 49th State: Commercial Marine Inventory for Alaska

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Objective

- Determine Types of Commercial Marine Vessels Calling at Select Ports in Alaska
- Collect Data to Characterize 2002 Vessel Activity
  - Number of Ships
  - Engine Characteristics
  - Time-in-mode
- Develop Annual and Seasonal 2002 Port-Specific Emission Estimates
- Develop Projections for 2005 and 2018
Alaska Ports in Study
Vessel Categories - Ocean-Going

- Cargo Freight Ships
  - General Cargo
  - Container
  - Roll-On/Roll-Off
  - Tankers
Vessel Categories - Ocean-Going

- Passenger Cruise Ships
- Towboats/Barges
Vessel Categories - Harbor Vessels

- **Ferries**
  - Alaska Marine Highway System
    - commuter and tourist ferry

- **Fishing Vessels**
  - Commercial and Charter Boats

- **Harbor Tugs**
Fishing Vessels and Tugs
Activity Calculations

Activity calculated using the following equation:

\[ Activity_{\text{mode}} = Power \times Load\ Factor \times Time_{\text{mode}} \times Calls \]

where:

- \( Activity_{\text{mode}} \) = activity by mode (kilowatt [kW]-hours)
- \( Power \) = rated engine power by vessel and engine type (kWs)
- \( Load\ Factor \) = load factor of the engine by vessel type and mode
- \( Time_{\text{mode}} \) = time in mode per call by vessel type (hours)
- \( Calls \) = number of port calls by vessel and engine type
Activity Calculations

- Four activity modes
  - Cruise
  - Reduced-speed zone (RSZ)
  - Maneuver
  - Hotelling

- Account for In-Port and Underway Activity
  - up to 25 miles outside of harbor area
Ocean-Going Vessel Data

- 2004 Vessel Call Data
  - Calls by Port provided by the Marine Exchange of Alaska (MXAK)
  - 2002 Data Incomplete
    - 2004 backcasted to 2002 using MXAK adjustments
  - Data provided by
    - vessel type
    - engine type (diesel or steam)
    - engine size
Ocean-Going Diesel Engine Assignments

- Not Specified in MXAK Database
- Medium-speed, diesel-electric
  - Large cruise ships
  - Tankers
  - Roll-on/Roll-offs
- Slow-speed
  - Small cruise ships
  - Bulk carriers
  - General cargo
  - Container ships
Ocean-Going Calculations by Port and Vessel Type

- Calculated Average Propulsion and Auxiliary Engine Power
- Developed Average Time-in-mode Values
  - Used MXAK data for hotelling
  - Data from EPA typical ports for cruising speed in 25-mile cruise zone
  - RSZ and maneuvering times obtained from pilots for Dutch Harbor, Juneau, and Ketchikan
    - Other ports based on EPA procedures
Ferry Activity Data

- **Alaska Marine Highway System**
  - Compiled number of calls by port and vessel from ferry schedule
  - Obtained engine horsepower and service speed
  - Service speed used in cruise mode calculations
Ferry Activity Data

- **Times for Maneuvering and RSZ**
  - Estimated using EPA procedures
  - Maneuvering time assumed 1 hour per call
  - RSZ based on assumed round-trip distance of 10 miles, traveling at 65% of service speed

- **Hotelling**
  - Estimated as 2 hours per call per the Marine Exchange of Alaska
Fishing Activity Data

- Source: Alaska Dept of Fish and Game Commercial Fisheries Entry Commission
- Tracks receipts for fish tickets, for each landing made by licensed fishing vessel
- Provided total number of boats making fish landings at each port
- Provided vessel attribute database
  » Matched on vessel license to estimate the number of vessels by fuel type and horsepower by port
Fishing Activity Data

- Compiled vessel counts by port for charter fishing boats, also available from CFEC
- Available information on hours of operation per year not identified
  » Many fisheries in Alaska, activity depends on length of fishing season, how long to catch quota
- Based on fishing vessel study in Midwest Region
  - 475 hours per year
Fishing Activity Data – Dutch Harbor

- Vessel counts treated as calls since most fishing occurs beyond 25-mile limit
  - Time-in-mode estimated similar to all ocean-going vessels
  - Significant hotelling times, averaging 103 hours per call
Emission Inventory – Load Factors

- Propulsion Engines
  - EPA-recommended load factors developed for CMV rulemakings
    - Vary by vessel type and time-in-mode

- Auxiliary Engines
  - Based on study performed by the Port of Los Angeles
    - Vary by vessel type and mode
Emission Inventory – Emission Factors

- Propulsion and Auxiliary Engines by Vessel Type Assigned as Category 1, 2, or 3
  - EPA Category 3 emission factors
    - Vary by vessel type, engine type and mode
  - EPA Category 1 and 2 emission factors

- Gasoline Fishing Vessels
  - Used NONROAD model data for recreational 4-stroke gasoline inboard engines
Emission Inventory Calculations

- Calculated Annual Emissions by:
  - multiplying activity in kW-hours by emission factors in grams per kW hours, convert to tons
- Summer and Winter Season Emissions
  - Calculated based on seasonal calls by port and vessel type
- SCCs Assigned for Each Vessel Category
- Port Emissions Assigned to Boroughs (counties)
## 2002 Annual Emissions by
Alaskan Port and Pollutant

<table>
<thead>
<tr>
<th>Port</th>
<th>Borough</th>
<th>NOx</th>
<th>CO</th>
<th>SO2</th>
<th>PM25-PRI</th>
<th>VOC</th>
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<tbody>
<tr>
<td>Anchorage</td>
<td>Anchorage</td>
<td>277.1</td>
<td>67.9</td>
<td>202.5</td>
<td>23.8</td>
<td>7.4</td>
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<tr>
<td>Dutch Harbor</td>
<td>Aleutians West</td>
<td>1,185.4</td>
<td>187.1</td>
<td>307.5</td>
<td>42.7</td>
<td>19.3</td>
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<tr>
<td>Homer</td>
<td>Kenai Peninsula</td>
<td>247.9</td>
<td>206.2</td>
<td>72.0</td>
<td>7.8</td>
<td>15.2</td>
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<tr>
<td>Nikiski</td>
<td>Kenai Peninsula</td>
<td>285.8</td>
<td>48.4</td>
<td>128.7</td>
<td>13.4</td>
<td>4.5</td>
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<tr>
<td>Juneau</td>
<td>Juneau</td>
<td>1,631.3</td>
<td>254.1</td>
<td>839.8</td>
<td>114.0</td>
<td>53.5</td>
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<tr>
<td>Ketchikan</td>
<td>Ketchikan</td>
<td>1,611.2</td>
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<td>754.7</td>
<td>101.2</td>
<td>58.3</td>
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<tr>
<td></td>
<td>Gateway/Prince of Wales - Outer Ketchikan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kivalina</td>
<td>Northwest Arctic</td>
<td>27.2</td>
<td>3.4</td>
<td>11.5</td>
<td>1.3</td>
<td>0.5</td>
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<tr>
<td>Kodiak</td>
<td>Kodiak Island</td>
<td>280.0</td>
<td>113.6</td>
<td>102.9</td>
<td>12.5</td>
<td>12.1</td>
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<tr>
<td>Valdez</td>
<td>Valdez-Cordova</td>
<td>859.5</td>
<td>299.7</td>
<td>584.6</td>
<td>64.5</td>
<td>23.4</td>
</tr>
</tbody>
</table>
2002 Annual NO$_x$ Emissions by Alaskan Port and Vessel Type
Emission Inventory
Main Contributors by Port

- Container and Freight Cargo Ships
  - Anchorage, Dutch Harbor, Kivalina, and Kodiak
- Cruise Ships and Ferries
  - Juneau and Ketchikan
- Tankers
  - Homer, Nikiski, Valdez
- Fishing Vessels
  - Homer, Kodiak
- Tugs
  - Valdez has highest activity since 2 tugs assumed for each tanker call
2002 Annual NO\textsubscript{x} Emissions by Vessel Type for Homer
Emission Projections – Growth Factors

- **Cruise Ships**
  - Forecasts developed for Port of Ketchikan study, used for all other cruise ports

- **Ocean-going Vessels and Tugs**
  - Linear extrapolations of historic national freight data from *Waterborne Commerce of the US*

- **Ferries**
  - Based on Alaska State-level population forecasts

- **Fishing Vessels**
  - Extrapolations of historic State total fish landings
Emission Projections

- Projections Developed for 2005 and 2018
- All Categories showed Modest Growth in 2005
  » Average growth factor of 1.1
- Continued Growth in 2018
  » Average growth factor of 1.6
- Gas Turbine Cruise Ships
  » Assumed constant per cruise lines
    - No plans to purchase new gas turbine ships in near future due to high cost of fuel to run turbine
Recommendations

- **MXAK Vessel/Engine Data**
  - Confirm engine assignments as slow versus medium speed
  - Verify engine horsepower calculated from number of engines and available power

- **Time-in-Mode Data Based on EPA Defaults**
  - Data needed from pilots during busiest time (June), and many could not fulfill request
  - Actual data from pilot associations would improve activity and emissions
Recommendations – Fishing Vessels

- Limited data on annual hours and areas of operation
- Survey likely needed to refine these data - Alaska fisheries are numerous and operation depends on fishery
Recommendations

- Use of Shore Power (started in 2003) not accounted for in projections
- If shore power use increases, will result in decreased hotelling emissions