

NONROAD Population & Activity Update

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MOVES FACA Review Workgroup
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Big Picture Context

- **MOVES2013-NONROAD**
 - Initial release NONROAD2008a version within MOVES as “draft”
 - Data consistent with NONROAD2008a
 - Table-driven framework will be used to incorporate new NONROAD data
- **NONROAD Updated Population & Activity Draft**
 - Release post-MOVES2013
 - Include proposed data updates
 - Provide public comment
- **NONROAD Final Population & Activity Update**
 - Incorporate public comments
 - Finalize for regulatory requirements

Agenda

- **Scope of NONROAD Data Update**
 - Population
 - Activity
- **Status of NONROAD Data Update**
 - Data Acquisition
 - Data Review
 - Data Validation
- **Next Steps**
 - Potential NONROAD Updates

Population & Activity Update

- **Population**

- **Base Year Population**
 - Purchased Power Products Marketing Inc. (PPM) population database
 - Population based on sales data of nonroad equipment
 - Sales based on CY 1990-2012
 - Census of Agriculture (2003, 2007)
- **County Allocation**
 - New county allocation estimates provided with PPM data purchase
 - Review/revisit county allocation surrogates
- **Historic/Future Years**
 - Evaluate current data with historic years consistent with PPM & census data
 - Revisit methodology for estimating historic and future years

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The current base years in NONROAD2008a are 1996, 1998, 1999, or 2000 (depending on the equipment type).

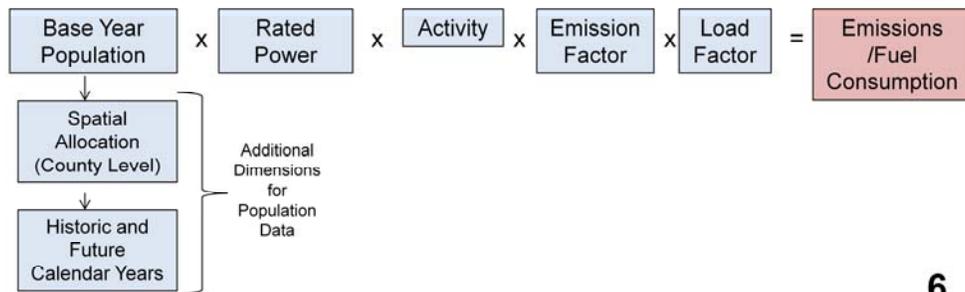
Population & Activity Update

- **Activity (annual operating hours)**
 - Purchased updated activity database of in-use equipment
 - 11 local and state recent activity survey studies compiled by ENVIRON
 - Activity estimates for vehicle on engine size and age of equipment
- **Load factors**
 - New data sources (i.e. EPA Midwest Construction Study)
 - Update in response to changes in activity/population and estimated fuel consumption

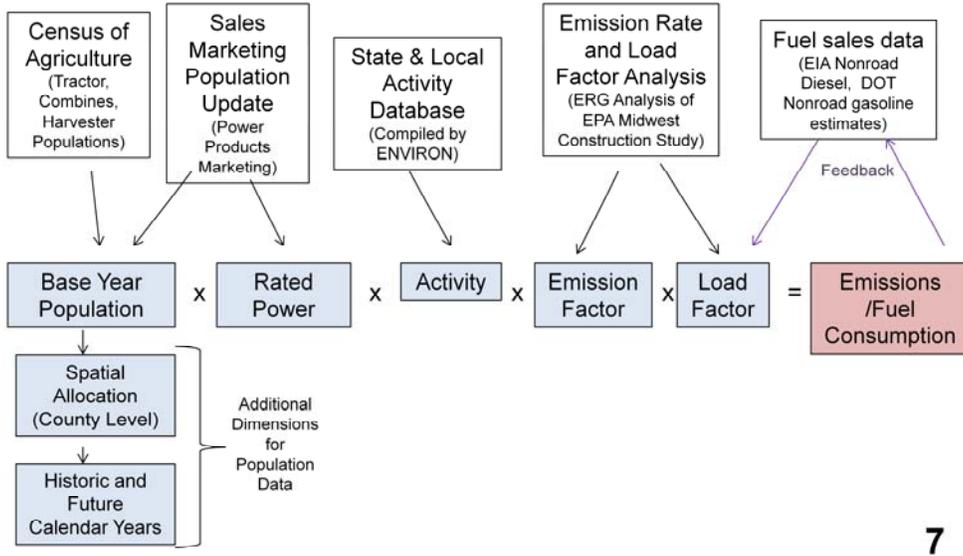
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The current activity is based primarily on 1998 database on surveys of equipment owners, and the activity estimates do not vary with equipment age. Load factors will need to be revisited with the population & activity update, but are not the focus of the presentation.

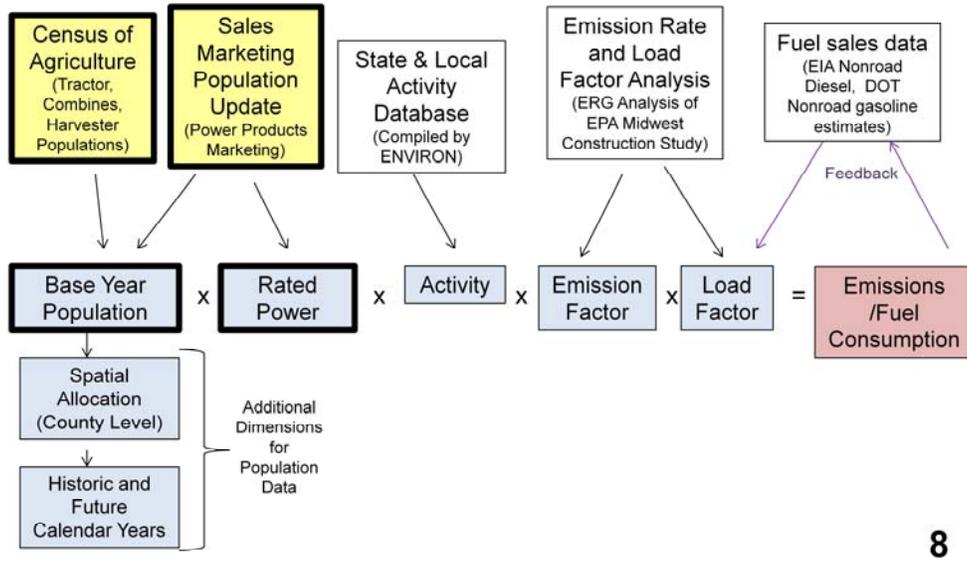
NONROAD Methodology



Proposed NONROAD Population & Activity Data Updates



Proposed NONROAD Population & Activity Data Updates



Population Data Acquisition

- **Power Products Marketing (PPM) Population Delivery**
 - Population Estimates for NONROAD Equipment in the US for CY 2012
 - Population classified according to:
 - Equipment Type
 - Fuel type (Gasoline 2- & 4-stroke/Diesel/LPG/CNG/Electric)
 - Engine Size
 - Model Year
 - Residential/Commercial (Lawn & Garden)
 - Population estimate based of historic sales and estimated scrapage and rebuild rates:
 - Population = Sales – Scrapped + Rebuilds
 - Population allocated to county level

Example: Tractor/Loader/Backhoe Population Population = Sales – Scraps + Rebuilds

| | | 2012 est | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 |
|-------|-------------------|----------|--------|--------|--------|--------|--------|--------|--------|
| SALES | Diesel | | | | | | | | |
| | 16.1-25 hp | 1,270 | 1,198 | 1,112 | 1,086 | 1,235 | 1,520 | 1,540 | 2,150 |
| | 25.1-40 hp | 1,415 | 1,275 | 1,148 | 1,017 | 1,240 | 1,680 | 1,860 | 1,825 |
| | 40.1-50 hp | 600 | 531 | 481 | 381 | 467 | 606 | 762 | 1,138 |
| | 50.1-75 hp | 846 | 790 | 910 | 1,385 | 3,288 | 4,717 | 5,056 | 5,215 |
| | 75.1-100 hp | 18,049 | 17,196 | 16,650 | 15,119 | 17,502 | 19,923 | 22,794 | 24,037 |
| | 100.1-175 hp | 1,640 | 1,530 | 1,375 | 970 | 727 | 381 | 567 | 605 |
| | Gasoline 4 stroke | | | | | | | | |
| | 16.1-25 hp | 985 | 905 | 860 | 780 | 1,015 | 1,190 | 1,275 | 1,460 |

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| | | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 |
|---------------|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| SCRAP PROFILE | Diesel | | | | | | | | |
| | 16.1-25 hp | 0.10% | 0.50% | 1.50% | 2.50% | 3.50% | 5.00% | 5.50% | 7.00% |
| | 25.1-40 hp | 0.10% | 0.50% | 1.50% | 2.50% | 3.50% | 5.00% | 5.50% | 6.50% |
| | 40.1-50 hp | 0.10% | 0.50% | 1.50% | 2.50% | 3.50% | 5.00% | 5.50% | 6.00% |
| | 50.1-75 hp | 0.10% | 2.00% | 3.00% | 4.00% | 5.00% | 6.00% | 6.50% | 7.00% |
| | 75.1-100 hp | 0.10% | 2.00% | 3.00% | 4.00% | 5.00% | 6.00% | 6.50% | 7.00% |
| | 100.1-175 hp | 0.10% | 2.00% | 3.00% | 4.00% | 5.00% | 6.00% | 6.50% | 7.00% |
| | Gasoline 4 stroke | | | | | | | | |
| | 16.1-25 hp | 0.10% | 0.50% | 1.50% | 2.50% | 3.50% | 5.00% | 5.50% | 7.00% |

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The PPM population estimate for Tractor/Loader/Backhoe is illustrated with data. The sales data is the basis of the population estimate. The sales data by model year and horse-power/fuel type is provided in the top table. The sales data extends from 2012 to pre-1990, although only data in the most recent 7 years is shown.

The estimated number of scrapped T/L/B are subsequently subtracted from the sales, using the provided estimated scrapped percentages in the bottom table.

Example: Tractor/Loader/Backhoe Population Population = Sales – Scraps+ Rebuilds

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| | | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 |
|---------------|-------------------|------|------|------|-------|-------|-------|-------|-------|
| REBUILD RATES | Diesel | | | | | | | | |
| | 16.1-25 hp | | | | | | | | |
| | 25.1-40 hp | | | | | | | | |
| | 40.1-50 hp | | | | | | | | |
| | 50.1-75 hp | | | | | | | | |
| | 75.1-100 hp | | | | | | | 5.00% | 5.00% |
| | 100.1-175 hp | | | | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% |
| | Gasoline 4 stroke | | | | | | | | |
| | 16.1-25 hp | | | | | | | | |

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| | | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | |
|-------------|-------------------|--|--------|--------|--------|--------|--------|--------|--------|--------|
| POPULATION | | 2012 Calendar Year population (All Model Years) | | | | | | | | |
| | Diesel | | | | | | | | | |
| | 16.1-25 hp | 21,944 | 1,269 | 1,192 | 1,095 | 1,059 | 1,192 | 1,444 | 1,455 | 2,000 |
| | 25.1-40 hp | 16,136 | 1,414 | 1,269 | 1,131 | 992 | 1,197 | 1,596 | 1,758 | 1,706 |
| | 40.1-50 hp | 8,200 | 599 | 528 | 474 | 371 | 451 | 576 | 720 | 1,070 |
| | 50.1-75 hp | 43,315 | 845 | 774 | 883 | 1,330 | 3,124 | 4,434 | 4,727 | 4,850 |
| | 75.1-100 hp | 244,097 | 18,031 | 16,852 | 16,151 | 14,514 | 16,627 | 18,728 | 21,386 | 22,439 |
| | 100.1-175 hp | 10,601 | 1,638 | 1,499 | 1,334 | 933 | 692 | 359 | 532 | 565 |
| | Gasoline 4 stroke | | | | | | | | | |
| | 16.1-25 hp | 15,795 | 984 | 900 | 847 | 761 | 979 | 1,131 | 1,205 | 1,358 |
| Total Pop = | 360,087 | | | | | | | | | |

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The number of rebuilds are also used to estimate the population. The data with the estimated % of scrapped T/L/B s that are rebuilt is provided in the top table. The estimated number of rebuilt T/L/Bs are added back to (Sales-Scraps) to estimate the population.

The estimate of population is shown in the bottom table on slide 11. Each cell in the population table represents the population of T/L/B's by model year and engine size/fuel type estimated to exist in calendar year 2012. By summing across all rows and columns, we obtain the total population estimate for T/L/B's in existence in calendar year 2012.

Note that scrap and rebuild percentages all are based on a 2012 calendar year. The population estimates are limited to calendar year 2012. To estimate previous years, scrappage and rebuild rates specific to the historic year will need to be estimated.

PPM Population Estimation Methodology

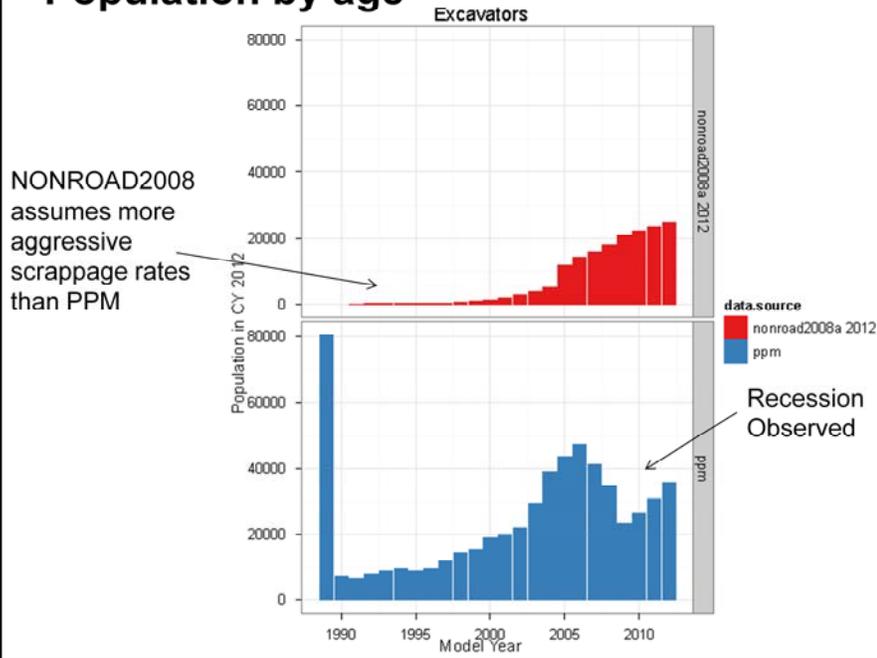
- **Sales Data**

- Historic Sales from 1990-2012, with estimates of all pre-1990 sales
 - Proprietary US dealer surveys
 - Used for most equipment types
- US Census Current Industrial Reports used in some cases:
 - Aerial Lifts, Sweepers, Logging Equipment, Oil Field Equipment, and Locomotives
- Sales data shows impact of recession

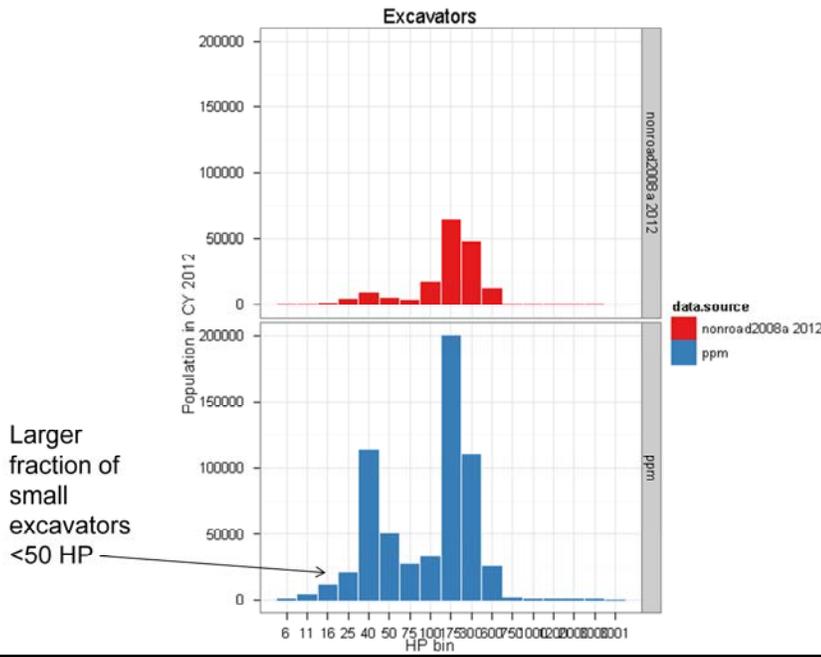
PPM Population Estimation Methodology

- **Scrappage and Rebuild rates based on:**
 - Industry knowledge
 - Cumulative hours of equipment compared to estimated median life
 - Median life estimates obtained from NONROAD2008
 - Cumulative Hours obtained from Auction Data
 - Top Bid Auction data ((Randall Reilly Publishing)
 - 139,966 records with cumulative hours at time of auction
 - Provides estimate of cumulative hours by age of machine
 - Semi-qualitative scrappage estimates
 - PPM scrappage rates are generally less aggressive than in NONROAD2008a (equipment lasts longer)
- **Population compared with NONROAD2008a and Census of Agriculture Data**

Example Data: NONROAD vs. PPM 2012 Population by age



Example Data: NONROAD vs. PPM 2012 Population by engine size



Population Estimates: NONROAD and PPM: Heavy Construction

| | NONROAD 2008a (CY 2012) | PPM (2012) |
|---------------------------|-------------------------|------------------|
| Crawler | 128,506 | 251,035 |
| Rubber Tire Loaders | 188,669 | 509,131 |
| Tractors/Loaders/Backhoes | 454,663 | 597,284 |
| Skid Steer Loaders | 709,240 | 850,511 |
| Scrapers | 22,628 | 16,349 |
| Excavator | 167,210 | 596,193 |
| Motor Grader | 39,870 | 121,627 |
| Off Highway Trucks | 20,999 | 80,141 |
| All Heavy Construction | 1,731,786 | 3,022,271 |

- Example of consistent categories between NONROAD2008a and PPM
- Population estimates are generally larger in PPM database than NONROAD2008a

Population Estimates: NONROAD and PPM Lawn & Garden

| | NONROAD 2008a (CY 2012) | PPM (2012) |
|--|-------------------------|-------------------|
| Rotary Tillers < 6 HP (res) | 4,534,995 | |
| Rotary Tillers < 6 HP (com) | 756,715 | |
| Chain Saws < 6 HP (res) | 7,092,512 | |
| Chain Saws < 6 HP (com) | 991,165 | |
| Chain Saws > 6 HP | 52,970 | |
| Trimmers/Edgers/Brush Cutter (res) | 19,033,358 | |
| Trimmers/Edgers/Brush Cutter (com) | 2,526,240 | |
| Leafblowers/Vacuums (res) | 9,995,222 | |
| Leafblowers/Vacuums (com) | 1,436,844 | |
| Hand Held Equipment: Consumer (Residential) | | 48,909,783 |
| Hand Held Equipment: Commercial | | 14,710,092 |
| All Hand Held | 46,420,021 | 63,619,875 |

- Different source categories in PPM and NONROAD

NONROAD Source Categories

- **PPM Categories are not entirely consistent with current NONROAD categories**
 - Aggregation differences:
 - i.e. Handheld Lawn & Garden equipment vs. refined categories
 - Changes in definitions:
 - i.e. Rear engine mower (NONROAD) vs. Zero turn mower (PPM)
- **Updates to NONROAD Source Classification Codes (SCC) may be necessary**
 - Updates will need to be harmonized with activity and emission rates
 - Intend to harmonize with NONROAD2008a and California OFFROAD categories where possible

Census of Agriculture Population Comparisons

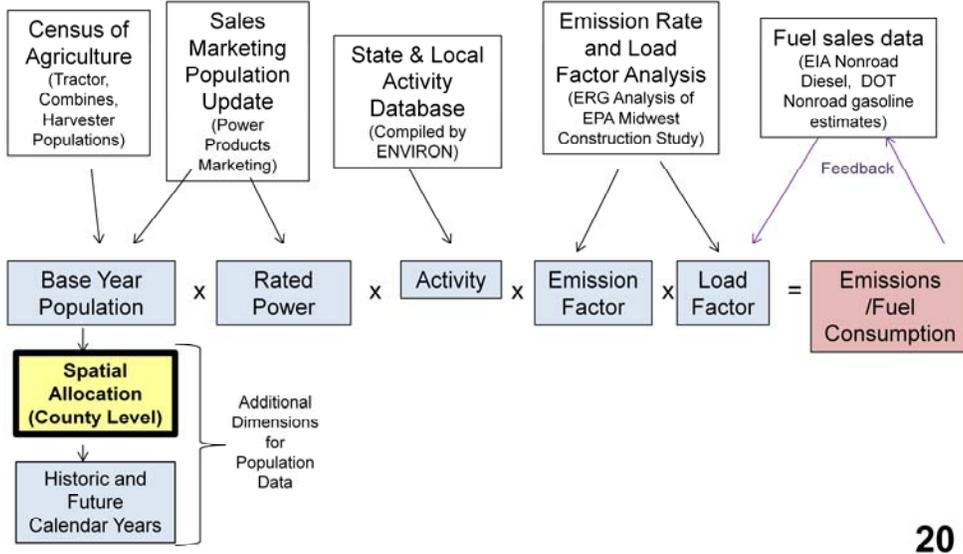
| Agricultural Tractors (National Estimates) | | |
|--|---------------------|-----------------------|
| Census of Agriculture (2007) | NONROAD (1998/2000) | Sales Data PPM (2012) |
| 4,389,812 | 1,431,597 | 3,764,748 |

- PPM and Census of Agriculture population counts are comparable
- NONROAD2008a appears to underestimate tractor population
- Census of Agriculture includes higher percentage of small tractors

| Diesel Fuel Consumption (gallons) estimate in CY 2007 | | |
|---|---|--|
| EIA Agriculture Sector Diesel (2007) | NONROAD 2008a (with current agriculture population) | NONROAD (updated with Census of Agriculture pop) |
| 3,443,685,000 | 3,800,930,562 | 8,062,624,273 |

- Current NONROAD fuel consumptions compare well with EIA
- Engine size, load factors and activity need to be revisited if population is updated in NONROAD

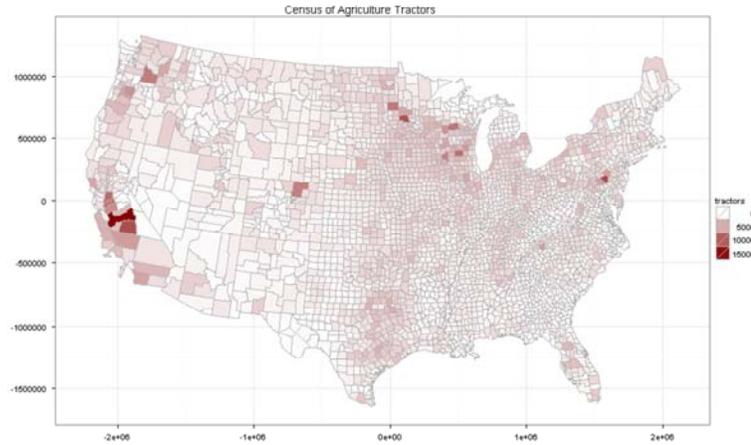
Proposed NONROAD Population & Activity Data Updates



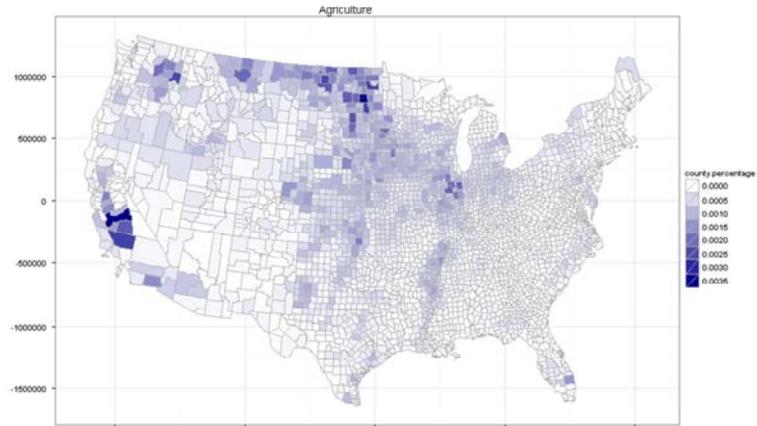
PPM County Allocation

- **PPM County allocation sources:**
 - Unified Commercial Code (Primary source)
 - Publically available data on equipment purchased through banks or finance firms
 - State registration data (State-Level)
 - Marine, Snowmobiles
 - Single detached homes (County-Level)
 - Lawn & Garden, Marine, Snowmobiles
- **Review of PPM geographic allocation**
 - Compared to Census of Agriculture
 - Compared to current NONROAD county allocation factors

Example Tractor Distribution: Census of Agriculture, 2007

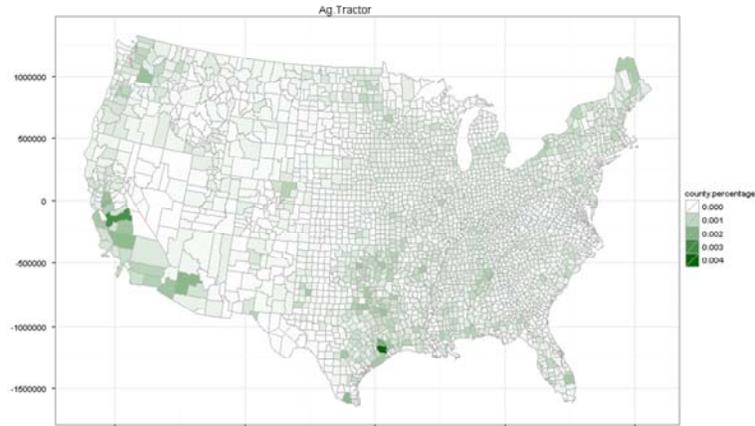


Example Tractor Distribution: NONROAD2008a (Based on Surrogate: Harvested Acres)



Surrogates limitations (i.e. likely overprediction of tractors in Dakotas and Montana, underestimation in East Coast, Midwest, TX)

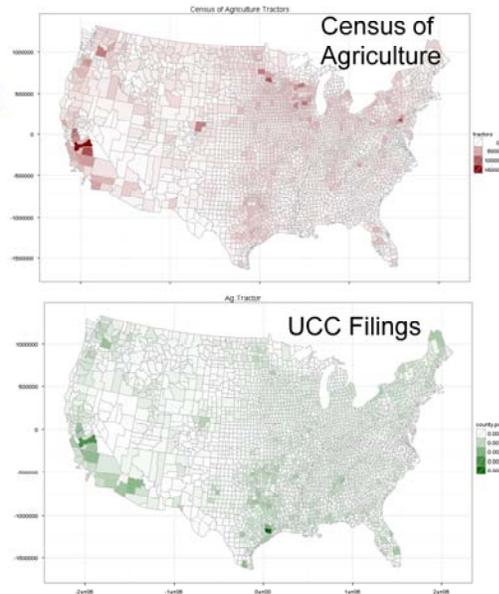
Example Tractor Distribution: PPM 2012 (Based on UCC Filings)



UCC filings based on Point of Sale. Appear to overemphasize larger counties (i.e. Harris County (Houston), TX). Under predict tractors in upper midwest

Geographic Allocation: UCC filings

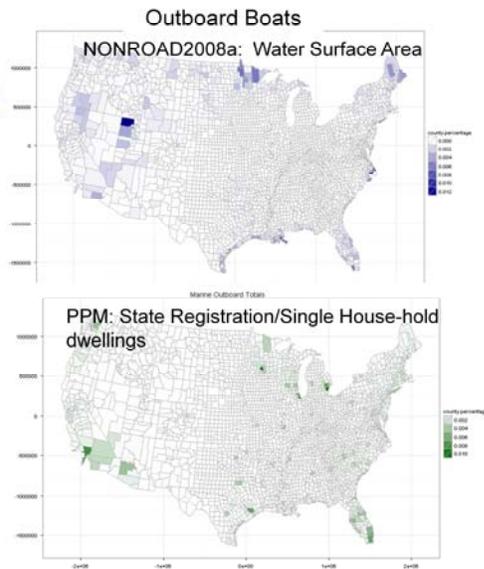
- **UCC advantages:**
 - Based on sales data
 - Working with PPM to assure data quality for all sources
 - Provides intuitive allocation for many sources
- **UCC disadvantages:**
 - Point of sale may differ than point of operation
 - Based on sales from 2005, 2007, 2009, 2011
 - Using recent sales data may not reflect population allocation well for long-life equipment



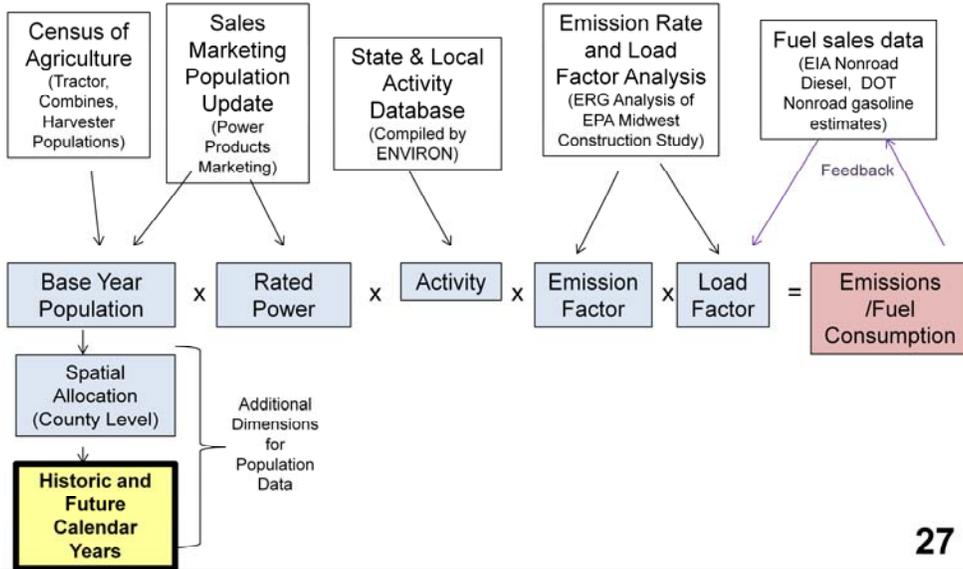
UCC: Uniform Commercial Code—based on financed nonroad equipment

Geographic Allocation: Surrogates

- PPM used surrogates when UCC files were unavailable
 - Used state registration data (where available)
 - Used detached single homes to allocate recreational, marine within states, to overall allocate lawn & garden equipment
 - Differed than surrogates used currently in NONROAD2008a
- Systematic review of NONROAD2008a and PPM county allocation surrogates to be conducted



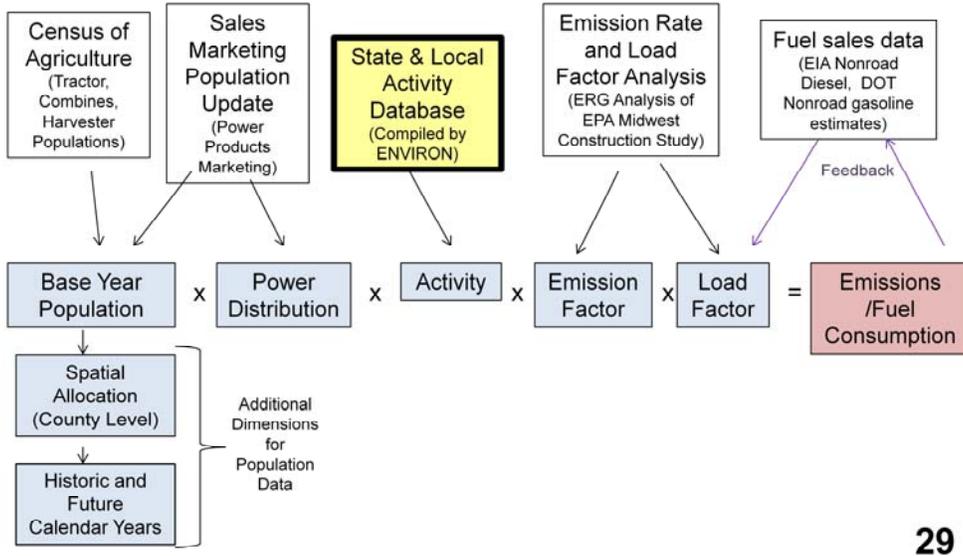
Proposed NONROAD Population & Activity Data Updates



NONROAD Future & Historic Year Population

- **PPM delivery does not provide population for historic and future years**
 - Scrappage/rebuilds and population estimate only provided for CY 2012
- **EPA is considering options for forecasting future years and estimating scrappage for historic years**
- **Population update may replace current historic years to provide consistent estimates with updated base year and equipment categories**

Proposed NONROAD Population & Activity Data Updates



Activity Survey Database

- **Hour/year activity estimates of nonroad equipment usage compiled from 11 studies by ENVIRON**
- **Activity differentiated by:**
 - Equipment type
 - Engine and/or Equipment Model Year
 - Age
 - Fuel type (Gasoline/Diesel/LPG/CNG/Electric)
 - Engine size (HP Bin)
 - Commercial/Residential (for Lawn & Garden)
- **40,281 activity records**
 - 37% Construction
 - 22% Agricultural
 - 21% Industrial
 - 19% Lawn & Garden

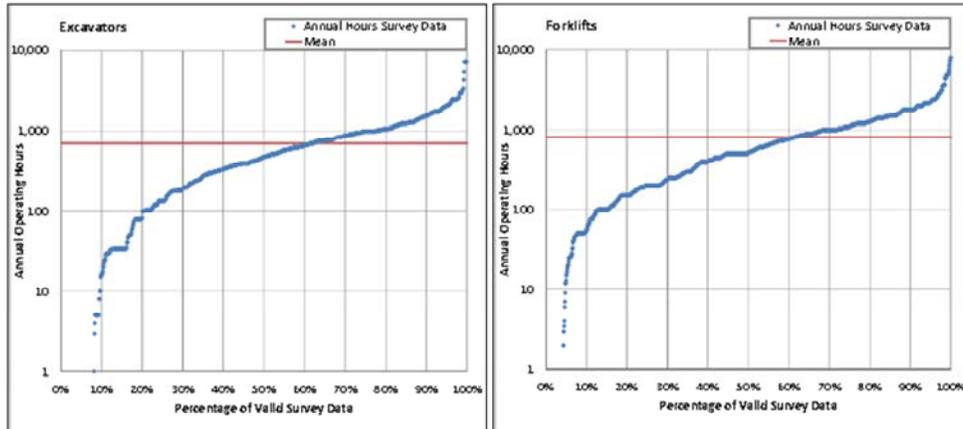
Activity Survey Studies

| Study Ref No. | Survey Study | Equipment Type | Ref |
|---------------|---|--|--------------|
| 1 | California Air Resources Board (ARB) In-use Off-road Diesel Rulemaking Support Documents; and Diesel Offroad On-line Reporting System (DOORS) | Construction, Industrial, Oil Drilling, Airport Ground Support Equipment | ARB, 2010 |
| 2 | ARB Transportation Refrigeration Unit Rulemaking Support Documents | Industrial Transportation Refrigeration Units | ARB, 2011b |
| 3 | ARB Lawn and Garden Equipment Survey | Lawn and Garden Equipment | ARB, 2003 |
| 4 | LADCO Construction Equipment NONROAD Emission Inventory Project | Construction | Pechan, 2004 |
| 5 | Texas Diesel Construction Equipment Updates | Construction | ERG, 2009 |
| 6 | Texas Farming Equipment Study | Agricultural | Pechan, 2009 |

Activity Survey Studies

| Study Ref No. | Survey Study | Equipment Type | Ref |
|---------------|---|----------------------------|-----------------------|
| 7 | Refining San Antonio Lawn and Garden Equipment Emission Estimates | Commercial Lawn and Garden | Smeltzer, 2007 |
| 8 | Development of Texas Statewide Commercial Lawn and Garden Emissions Estimates | Commercial Lawn and Garden | Baker and Wells, 2003 |
| 9 | Improvements to Lawn and Garden Equipment Emissions Estimates for Baltimore | Lawn and Garden | Reid, 2010 |
| 10 | Maricopa County 2002 Comprehensive Emission Inventory for the Cap and Trade Oversight Committee | Commercial Lawn and Garden | ENVIRO N, 2003 |
| 11 | ARB Cargo Handling Equipment Regulatory Supporting Documents | Cargo Handling Equipment | ARB, 2011a |

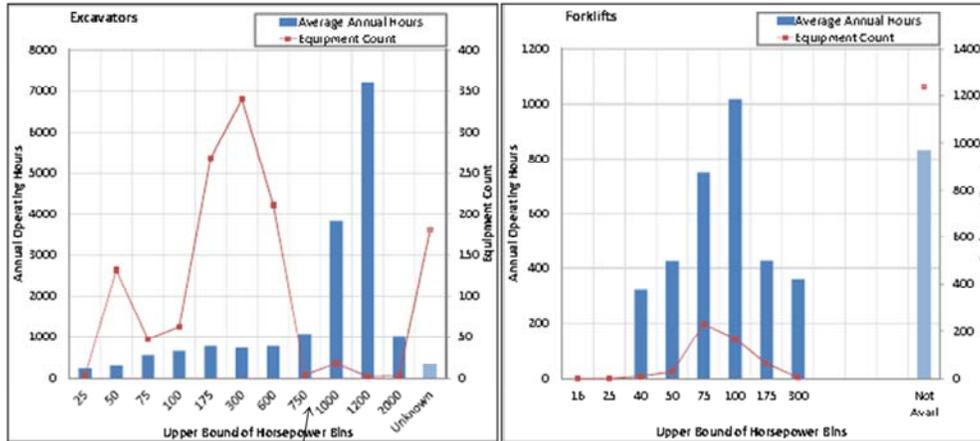
Example from Activity Database: Activity Distribution



Large distribution of usage rates for each equipment type

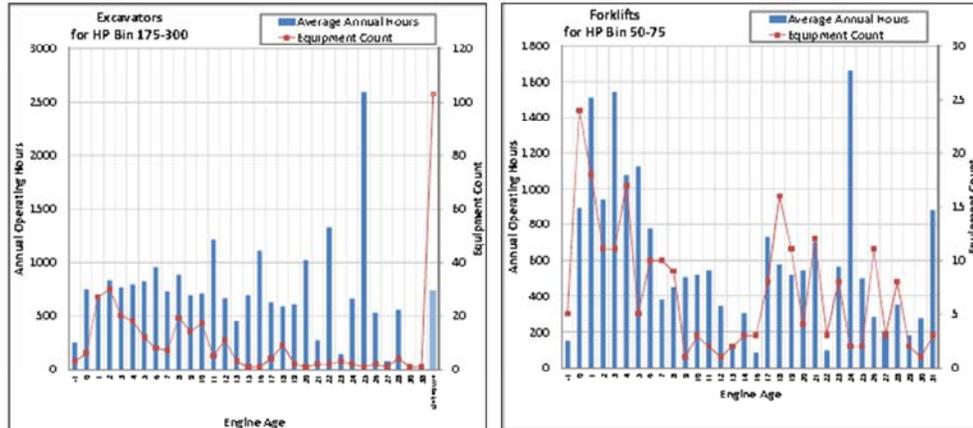
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Example from Activity Database: Activity by Engine Size



Some sources are based on limited data

Example from Activity Database: Activity by Age



NONROAD2008a usage rates do not vary across engine age

Review of Activity Survey

- **Comparison with survey data and NONROAD2008 default values**
 - Diesel Construction usage is generally lower
 - Excavators, tractors/loaders/backhoes, and graders
 - 35%, 40%, and 22% below NONROAD2008a
 - Commercial Lawn & Garden usage is generally higher
 - Leaf blowers, lawn mowers, rear engine riding mowers
 - 162%, 145%, and 92% higher than NONROAD2008a

Review of Activity Survey

- **Further data review and validation**
 - Review survey data with limited information
 - Large differences can be observed for small sample sizes (and small sources)
 - For example: commercial diesel chain saws
 - Survey data: 2920 hours/year (1 respondent)
 - Current NONROAD: 70 hours/year
 - Supplement database with additional studies with known activity data
 - Survey data provides estimates of usage by age
 - Potentially incorporate usage by age in NONROAD update

Next Steps in Population & Activity Data Update

1. Update NONROAD category definitions based on PPM data and available activity and emission factors
2. Propose approach to model growth and scrappage/rebuild in future/historic years
3. Update activity using survey database
4. Assess emissions/fuel impact of updating NONROAD with population and activity data
5. Revisit activity/load factors based on fuel consumption estimates
6. Select methods for geographical allocation of population for each source

References

- Nonroad Engine Population Estimates Report, 2010
- Geographic Allocation of Nonroad Engine Population Data to the State and County Level, 2005
- Calculation of Age Distributions in the Nonroad Model: Growth and Scrapage, 2005
- Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling, 2010
- Chris Lindhjem, John Grant, and Lan Ma. NONROAD Growth & Activity Update. Draft Final Report. ENVIRON International Corporation. August, 2012
- Greg Boeder, Power Products Marketing. Off-road Equipment Historic Sales, 2012 In-Use Population Estimates, Scrapage and Rebuild Rates, and Auction Activity Data. Memorandum. September, 30, 2012