E.H. Pechan & Associates, Inc.

Improvements to NONROAD Model Inputs for Midwestern States

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Overview

- Construction Activity Survey
  - Temporal Allocations
  - Equipment Activity and Populations
- Agricultural Equipment Study
  - Spatial Allocations
  - Temporal Allocations
- Comparison to NONROAD Defaults

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Construction Survey Design

- SICs sampled:
  - 16 – Heavy Construction Contractors
  - Specialty Trade Contractors:
    - 1771 – Concrete Work
    - 1794 – Excavation Work
    - 1781 & 1795 – Drilling and Demolition
  - 4953 – Landfills
  - 10, 12, 14 - Mining
  - 7353, 7359, 5082 – Rental Equipment
- Computer Assisted Telephone Interview (CATI) performed by subcontractor Population Research Systems (PRS)

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Construction Questionnaire

- Equipment Owners and Rental Companies
  - Employment
  - Equipment Count for Each of 26 Equipment Types
    - Owned and Rented (report owned equipment separately from rented equipment to avoid double counting)
  - Characteristics of equipment
    - Fuel
    - Average Horsepower
- Equipment Owners Only
  - Construction operating schedules
    - Time of day
    - Weekday versus weekend day
  - Equipment Use by Equipment Type
    - Hours per week; weeks per year
    - Seasonal operating percentages

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Activity Data Analysis

- Activity Information Weighted by:
  - Equipment counts per respondent
  - Fraction of sampled versus total regional SIC employment
- Diurnal and Weekly Data
  - analyzed across all equipment types
- Annual Hours of Use and Seasonal Profiles
  - first analyzed by equipment type
  - aggregated across equipment types

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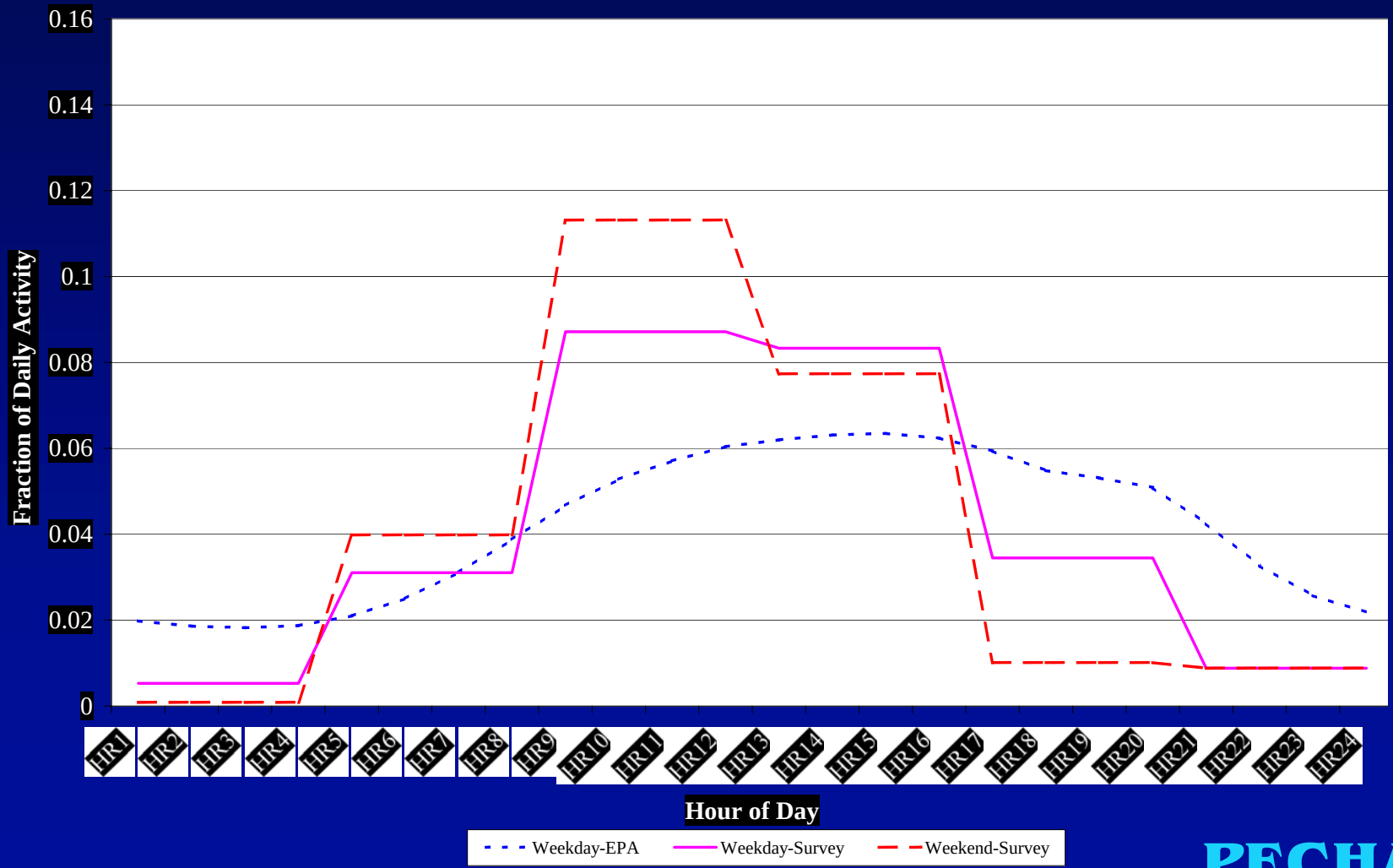
Temporal Profiles – Diurnal



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Temporal Profiles – Weekly

- Weekday/Weekend Day Profiles
  - NONROAD model
    - Weekday activity 2 times higher than weekend day activity
  - Survey
    - Weekday activity close to 4 times higher than weekend activity

Temporal Profiles – Seasonal

- Seasonal Percentages
  - Analysis of variance (ANOVA) between data for paving/surfacing-related and all other equipment found significant differences

Category	Winter	Spring	Summer	Fall
NONROAD - All Construction	10%	23%	43%	23%
Survey - Paving and Surfacing	12%	21%	38%	29%
Survey - All Other Construction	20%	19%	26%	36%

Annual Hours of Use and Horsepower

- Hours of Use Per Year:
  - Developed ratio of survey to NONROAD average across all applications
    - increased hours per year in NONROAD by 20 percent for all SCCs
- Average Horsepower (HP)
  - Weighted average HP comparable to weighted average HP in NONROAD model
  - Did not replace NONROAD HP distributions

Equipment Population – Equipment Owners

- Scaling factors developed by SIC and SCC
  - Calculated by dividing the number of pieces of owned equipment by the number of employees
- Example calculation for diesel rollers in SIC 1771

$$SF = Eq_{SCC,\ SIC} \div Emp_{SIC}$$

Where:

$SF_{SCC,\ SIC}$ = Scaling factor, for SCC/SIC combinations

$Eq_{SCC,\ SIC}$ = Equipment count from survey, by SCC and SIC; 8

Emp_{SIC} = Employment for surveyed respondents by SIC; 693

Resulting in:

$$SF_{SCC,\ SIC} = 8 \div 693 = 0.0115$$

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Equipment Population – Equipment Owners (cont'd)

- Application of scaling factors:

$$Eq_{SCC, Total} = SF_{SCC, SIC} * Emp_{Total}$$

Where:
- Eq_{SCC} = State equipment count, by SCC
- $SF_{SCC, SIC}$ = Scaling factor; 0.0115
- Emp_{ST} = State employment for SIC 1771; 7,207

Resulting in:

$$Eq_{SCC, Total} = 0.0115 * 7,207$$

$$= 83 \text{ diesel rollers}$$

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Equipment Population – Rental Equipment/Total

- Rental Equipment Scaling Factors
  - Developed using procedure similar to equipment owners
- State-level Rental Employment Adjusted for Non-Eligibility within Relevant SIC codes
  - Higher percentage of non-eligible businesses in rental SICs than user SICs
- Total Population
  - Results of owned equipment added to results of rented equipment to estimate total equipment population by SCC

Midwest Region Equipment Populations

Equipment Category	NONROAD Model Population	Survey Population	Difference	Equipment Category	NONROAD Model Population	Survey Population	Difference
Bore/Drill Rigs	21,332	9,353	-11,979	Paving Equipment	19,263	3,736	-15,526
Cement and Mortar Mixers	39,729	5,172	-34,557	Plate Compactors	20,197	32,096	11,899
Concrete/Industrial Saws	16,572	29,686	13,114	Rollers	13,074	9,608	-3,466
Cranes	4,522	3,540	-982	Rough Terrain Forklifts	16,296	9,160	-7,136
Crawler Tractor/Dozers	16,605	19,036	2,431	Rubber Tire Loaders	24,046	29,146	5,100
Crushing/Processing Equipment	2,544	4,184	1,640	Scrapers	3,137	5,059	1,921
Dumpers/Tenders	4,598	3,853	-745	Signal Boards/Light Plants	7,632	3,796	-3,836
Excavators	17,197	25,867	8,670	Skid Steer Loaders	71,993	30,089	-41,903
Graders	5,687	5,594	-93	Surfacing Equipment	3,314	4,600	1,285
Off-highway Tractors	***339***	***4,733***	***4,394***	Tampers/Rammers	23,267	17,340	-5,927
Off-highway Trucks	***2,328***	***16,104***	***13,776***	Tractors/Loaders/Backhoes	52,689	38,270	-14,419
Other Construction Equipment	***2,193***	***32,452***	***30,260***	Trenchers	12,131	29,098	16,967
Pavers	4,390	1,543	-2,847	**Total**	**405,073**	**373,114**	**-31,959**

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Limitations

- For most activity variables, sample obtained per SCC not large enough for replacing activity defaults by SCC
- Population results used for most equipment categories
  - Exceptions include Off-Highway Tractors and Other Construction Equipment
  - Data for Off-Highway Trucks undergoing review
- Results based on 390 establishments that represent 3 percent of the total regional employment

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Agricultural Category Overview

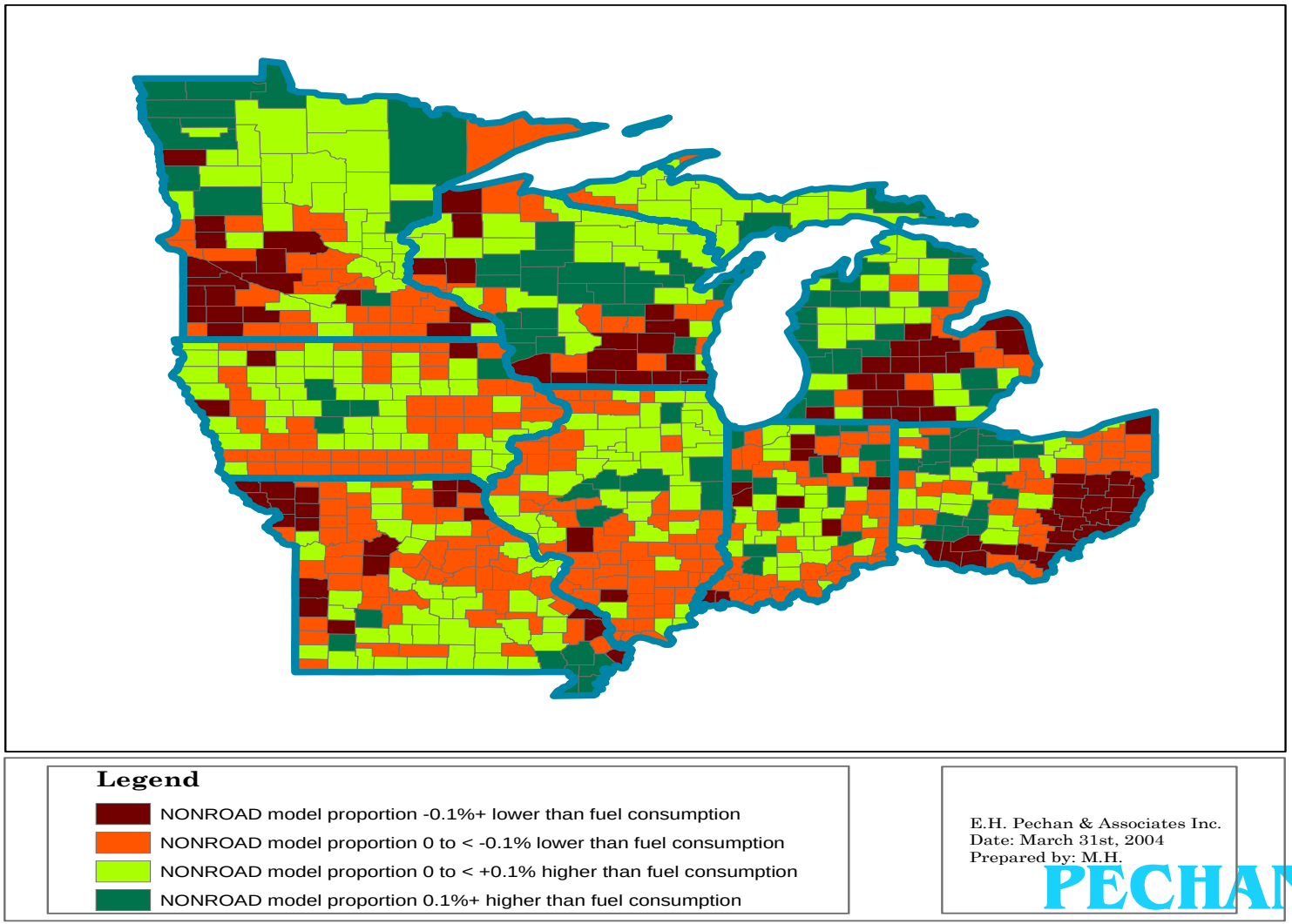
- NONROAD Model
  - National to County Spatial Allocation Based on 1992 Total Harvested Crop Acreage
  - Monthly Allocation Assumption for All Great Lakes/Midwest Region States
- LADCO Approach
  - Spatial and Temporal Allocations Based on Year 2002 Fuel Consumption Estimates

Spatial Allocation

- NONROAD Model
  - National Equipment Allocated to Counties Using Total Harvested Crop Acreage from 1992 Census of Agriculture
- LADCO
  - State Equipment Estimates (where available from 2002 Census of Agriculture) Allocated to Counties Using Diesel Fuel Consumption Estimates
    - Diesel Consumption Per Planted Acre by Crop for Major Crops (Corn, Hay, Oats, Sugar beets, Soybeans, Wheat)
      - U.S. Department of Agriculture State estimates from surveys
    - 2002 Planted Acreage By County for Major Crops
      - U.S. Department of Agriculture's "Crops County Data Files"

Spatial Allocation (cont'd)

Comparison of County to State Proportions Developed from NONROAD Model and Fuel Consumption Estimates



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Temporal Allocation

- NONROAD Model
  - Seasonal Allocation Assumption for All States in Great Lakes/Midwest Region
    - 50% in Summer (June-August)
    - 22% in Spring (March-May) and in Fall (September-November)
    - 6% in Winter
- LADCO
  - Year 2002 Weekly Diesel Fuel Consumption Estimates
  - State-Specific

Temporal Allocation (cont'd)

- LADCO
  - Identify Operations By Crop
  - Estimate Diesel Consumption By Operation
  - Estimate Time-Frame for Operation
  - Apportion Acres of Operation By Week
  - Calculate Weekly Diesel Consumption
    - Diesel Consumption by State by Crop (from Spatial Allocation) * Proportion of Diesel Consumption By Operation * Proportion of Operation By Week
    - Sum Across Operations and Sum Across Crops by State

Temporal Allocation (cont'd) – Identify Operations by Crop

Crop	Planting	Cultivation	Harvesting	Post-harvesting
Corn	√	√	√	√
Hay			√	
Oats	√		√	√
Soybeans	√	√	√	
Wheat	√		√	√

Temporal Allocation (cont'd) - Estimate Diesel Use By Operation

TABLE 1. ESTIMATION OF DIESEL FUEL USE FOR CORN OPERATIONS

#	OPERATION	EQUIPMENT	MN	IA	AVERAGE
1	Apply Fertilizer	Anhydrous Appl 130 MFWD	0.53	0.55	0.54
2	Offset Disc	12' 105 MFWD	0.83	0.85	0.84
3	Plant Corn	Row Crop Planter 60-130 MFWD	0.34	0.4	0.37
4	Rotary Hoe	21' 105 MFWD	0.18	0.2	0.19
5	Cultivate	15'-40' 60-200 MFWD	0.44	0.4	0.42
6	Combine Corn	Combine Corn Head 15-30' 220-275 HP	2.3	1.45	1.88
7	Haul Corn		0.2	0.2	0.20
8	Apply Herbicide	Boom Sprayer 50'	0.11	0.11	0.11
9	Chisel	Front Disc 16.3-21.3' 200 MFWD-310 4WD	0.97	1.1	1.04
		Planting (1-3)	1.70	1.80	1.75
		Cultivating (4-5)	0.62	0.60	0.61
		Harvesting (6-7)	2.50	1.65	2.08
		Post Harvesting (8-9)	1.08	1.21	1.15
		Total Fuel	**5.90**	**5.26**	**5.58**
		Planting	28.81%	34.22%	31.36%
		Cultivating	10.51%	11.41%	10.93%
		Harvesting	42.37%	31.37%	37.19%
		Post Harvesting	18.31%	23.00%	20.52%
			1.00	**1.00**	**1.00**

Notes:
MN figures taken from University of MN Extension Service FO-6696: Farm Machinery Economic Costs for 2004
IA Figures taken from IA State University Extension PM 709: Fuel Required for Field Operations.
Hauling figures taken from PM 709 and applied to all states.

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Temporal Allocation (cont'd) – Estimate Time-Frame by Operation

- Planting
  - USDA Crop Progress Data For 2002
- Harvesting
  - USDA Crop Progress Data For 2002
- Cultivation
  - Last 3 weeks of planting through 3 weeks before 1st week of harvesting (working assumption)
- Post-harvesting
  - Last 3 weeks of harvesting and one week after harvesting (working assumption)

Temporal Allocation (cont'd) – Apportion Iowa Corn Acres By Week

Week Ending	Total Planted (%)	Total Harvested (%)	Weekly Progress Planted	Weekly Progress Harvested	ACRES				Diesel Fuel (gal)
					Planted	Cultivated	Harvested	Post Harvesting	
Apr 14	1		1	0	123,000				177,446
Apr 21	12		11	0	1,353,000				1,951,909
Apr 28	33		21	0	2,583,000				3,726,371
May 5	53		20	0	2,460,000				3,548,925
May 12	86		33	0	4,059,000				5,855,726
May 19	94		8	0	984,000	878,571			1,861,375
May 26	98		4	0	492,000	878,571			1,151,590
Jun 2	100		2	0	246,000	878,571			796,697
Jun 9			0	0		878,571			441,805
Jun 16			0	0		878,571			441,805
Jun 23			0	0		878,571			441,805
Jun 30			0	0		878,571			441,805
Jul 7			0	0		878,571			441,805
Jul 14			0	0		878,571			441,805
Jul 21			0	0		878,571			441,805
Jul 28			0	0		878,571			441,805
Aug 4			0	0		878,571			441,805
Aug 11			0	0		878,571			441,805
Aug 18			0	0		878,571			441,805

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Temporal Allocation (cont'd) – Apportion Iowa Corn Acres By Week

Week Ending	Total Planted (%)	Total Harvested (%)	Weekly Progress Planted	Weekly Progress Harvested	ACRES				Diesel Fuel (gal)
					Planted	Cultivated	Harvested	Post Harvesting	
Aug 25			0	0					0
Sep 1			0	0					0
Sep 8			0	0					0
Sep 15		4	0	4			492,000		841,602
Sep 22		6	0	2			246,000		420,801
Sep 29		10	0	4			492,000		841,602
Oct 6		13	0	3			369,000		631,202
Oct 13		21	0	8			984,000		1,683,204
Oct 20		41	0	20			2,460,000		4,208,011
Oct 27		61	0	20			2,460,000		4,208,011
Nov 3		76	0	15			1,845,000		3,156,008
Nov 10		89	0	13			1,599,000		2,735,207
Nov 17		96	0	7			861,000	3,075,000	4,375,317
Nov 24		99	0	3			369,000	3,075,000	3,533,715
Dec 1		100	0	1			123,000	3,075,000	3,112,914
Dec 8			0	0				3,075,000	2,902,513
				Totals	**12,300,000**	**12,300,000**	**12,300,000**	**12,300,000**	**56,580,000**

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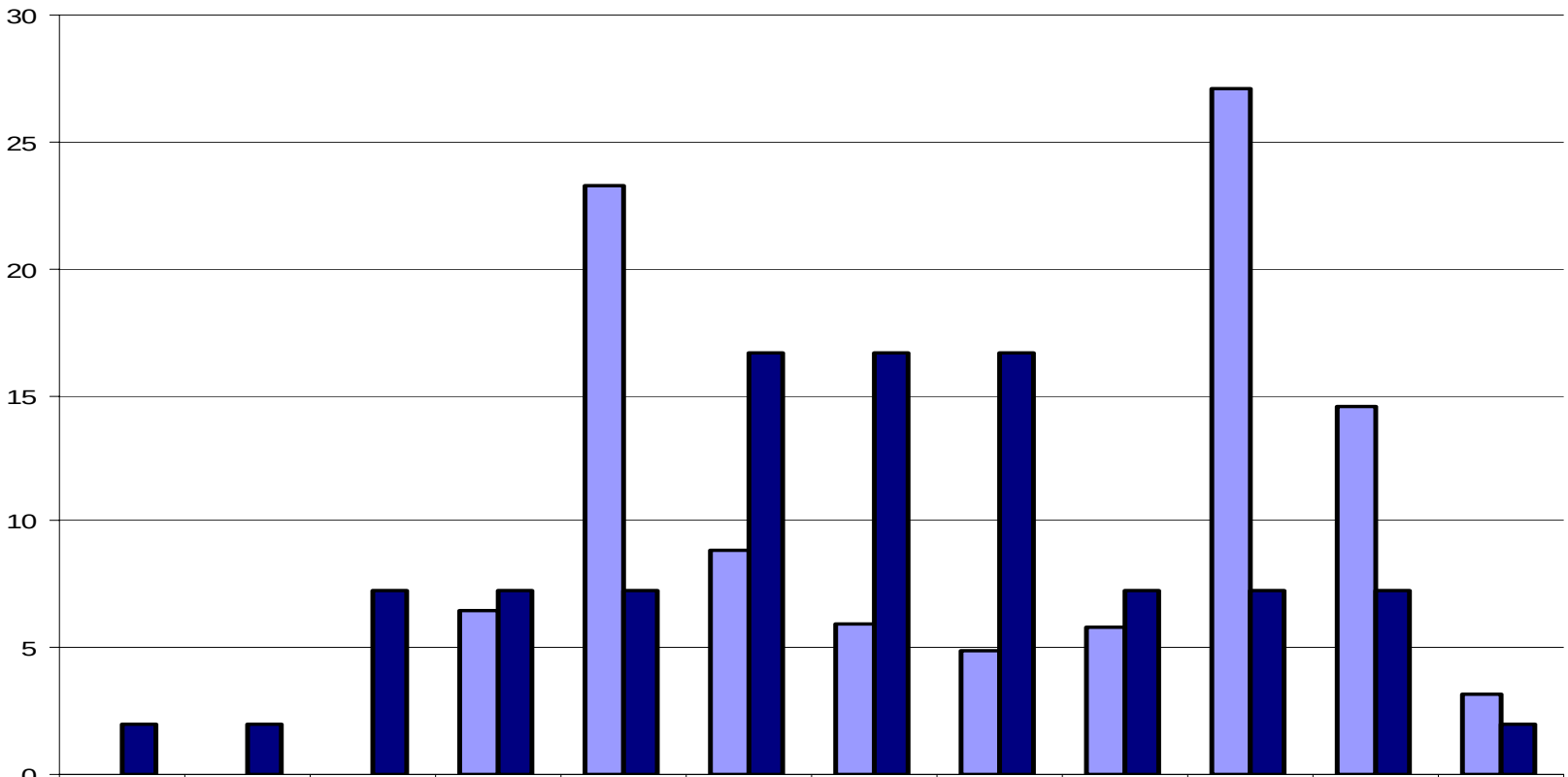
Temporal Allocation (cont'd) - NONROAD vs LADCO: Iowa



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
IA	0.0	0.0	0.0	6.4	23.2	8.9	6.0	4.9	5.8	27.1	14.5	3.1
NONROAD	2	2	7.3	7.3	7.3	16.7	16.7	16.7	7.3	7.3	7.3	2

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Temporal Allocation (cont'd) – Draft Crop Proportions & State Factors

CROP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Corn	0.0	0.0	0.0	6.6	17.1	12.6	3.5	2.8	6.2	17.3	24.1	9.7
Hay	0.0	0.0	0.0	1.0	14.6	26.0	24.2	12.5	16.0	5.6	0.0	0.0
Oats	0.0	0.0	4.7	13.9	8.2	1.9	30.0	30.6	10.7	0.0	0.0	0.0
Soybeans	0.0	0.0	0.0	0.4	12.9	22.9	7.7	7.7	7.3	34.3	6.3	0.5
Wheat	0.0	0.0	0.0	0.4	3.3	13.9	37.0	13.2	9.4	20.8	1.9	0.2

STATE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
IA	0.0	0.0	0.0	6.4	23.2	8.9	6.0	4.9	5.8	27.1	14.5	3.1
IL	0.0	0.0	0.0	4.1	10.9	20.9	6.6	5.5	6.9	30.1	9.6	5.4
IN	0.0	0.0	0.0	0.7	9.3	25.4	7.4	5.3	5.2	26.6	14.0	6.2
MI	0.0	0.0	0.0	1.2	15.8	16.5	9.4	6.9	6.0	22.5	15.2	6.4
MN	0.0	0.0	0.0	3.9	23.1	8.0	5.9	8.5	10.2	19.5	15.2	5.7
MO	0.0	0.0	0.1	8.3	9.0	22.5	9.1	6.4	13.2	18.2	12.3	0.9
OH	0.0	0.0	0.0	1.0	9.1	24.0	10.8	6.2	5.5	24.6	13.4	5.3
WI	0.0	0.0	0.0	2.1	19.7	12.6	7.0	6.9	4.7	14.7	22.4	10.0
Average	**0.0**	**0.0**	**0.0**	**3.5**	**15.0**	**17.3**	**7.8**	**6.3**	**7.2**	**22.9**	**14.6**	**5.4**
NONROAD Model	**2**	**2**	**7.3**	**7.3**	**7.3**	**16.7**	**16.7**	**16.7**	**7.3**	**7.3**	**7.3**	**2**

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Limitations

- Spatial Allocation
  - USDA Does Not Report Diesel Fuel Per Planted Acre Estimates For All Crops
    - Oats (used estimates for wheat per USDA)
    - Hay (developed from equipment-specific diesel consumption per harvested acre estimates from University of Minnesota and Iowa State University)
  - USDA hay acreage data do not indicate number of times harvested
    - Assumed 3 cuttings per year
  - Estimated withheld planted acreage

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Limitations (cont'd)

- Temporal Allocation
  - Major Assumptions
    - Crop Production Machine Operations (e.g., rotary hoe/cultivation used for corn?)
    - Timing of Cultivation and Post-harvesting Operations (e.g., all post-harvesting activity in Fall?)
    - Timing of Hay harvesting (assumed 3 cuttings/year beginning 3rd week in May, except MO-last week in April)
    - Crop progress not always reported for final week(s) (USDA stops reporting when 95% national coverage is achieved) – 100% assumed in first non-reported week
  - Excludes Sugar beets (minor impact)