

# Noise and vibration exposure in full-tree logging systems in the Southeastern U.S.A.

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# Why is this important?

- ▶ Logging is tough work: Can it be made it better, tough work?
- ▶ Equipment and processes have changed
- ▶ People have changed
  - ▶ Age
  - ▶ Fitness
  - ▶ People expect (need?) to work longer
- ▶ Costs
  - ▶ Medical and indemnity
  - ▶ Retaining good workers
- ▶ Personal – People want to retire and still feel good

# 2013 Survey Results

- Average age of 44 (range 19-67)
  - Average of 22.9 years in the logging industry (range 1-50)
  - Average body mass index of 31.3
  - 97% operate a machine at least once a month
- Of those operators:
- 11% reported a diagnosed MSD
  - 74% reported at least mild back pain over the past year
  - 72% reported at least mild neck pain
  - 50% knew someone who quit because of pain

# Whole body vibration (WBV)

- ▶ WBV levels associated with logging equipment have been shown to exceed standards
- ▶ These levels have been related to
  - ▶ Machine type
  - ▶ Age of the equipment
  - ▶ Manufacturer
  - ▶ Aggressiveness of the operator
- ▶ Awkward postures may increase risk





# WBV Exposure

- ▶ Long-term exposure to WBV contributes to
  - ▶ fatigue
  - ▶ central nervous system disturbances
  - ▶ lower back pain and injuries
  - ▶ vision problems
  - ▶ adverse effects to the digestive and genital/urinary systems
- ▶ Logging machine operators frequently work long hours, and duration of exposure to WBV has been related to low back pain more consistently than the magnitude of the vibration



# Noise

- ▶ Logging equipment in the U.S.A. has been shown to operate at noise levels that exceed the OSHA time weighted average of 90 dBA for full shift exposure.
- ▶ This can contribute to
  - ▶ Noise induced hearing loss (NIHL)
  - ▶ Fatigue
  - ▶ Poor operator concentration
  - ▶ Depressed mood
  - ▶ High blood pressure
- ▶ Other research suggests that WBV when combined with noise exposure has a synergistic effect on NIHL



# Methods

- To be included in the study, a crew had to have at least one skidder, one loader, and one feller-buncher in operation on any given day
- Crews were chosen based on the logging system used (mechanized rather than manual) and their relative proximity to Auburn, Alabama, U.S.A.
- Observation included an accelerometer (Larson Davis HVM 100) and personal noise dosimeters (Cirrus doseBadge)





# Methods

- ▶ Participants included 27 logging equipment operators from 7 different crews
  - ▶ 11 wheeled skidder operators
  - ▶ 7 wheeled feller-buncher operators
  - ▶ 9 loader operators
- ▶ Data were collected on 12 different days over an eight-week period in the summer of 2014
- ▶ Data collection also included machine parameters, anthropometric measurements, terrain ratings and GPS



# Methods

- Accelerometers were placed under the ischial tuberosities ("sit bones") of the operators in accordance with ISO 2631 – 1 1997 guidelines
- Accelerometer data recorded the vibration exposure of the operator with biodynamic root-mean square acceleration in three mutually perpendicular axes (x, y, and z) in accordance with ISO 2631 – 1 1997



# Methods



- Dosimeters were placed on the shoulder of an operator in their hearing zone
- The dosimeters were data logging and measured the noise exposure on two channels:
  - OSHA permissible exposure limit, which is based on a 90 dBA criterion level, 80dBA threshold level, a 5dBA exchange rate, 115 dBA ceiling, and a slow response
  - ISO European Union standards with an 80 dBA criterion level, a 3 dBA exchange rate, and fast response



# Methods

- ▶ The accelerometers and dosimeters were placed before the shift
- ▶ Devices were removed after at least four hours of self-reported representative work
- ▶ Participants were also asked to complete a survey developed to assess
  - ▶ worker demographics
  - ▶ frequency of machine use
  - ▶ machine preference
  - ▶ machine age
  - ▶ time spent in particular postures
  - ▶ and neck and back pain experienced over the past year



# Survey Results

- Survey responses were collected for 26 participants (96% response rate)
- Average age of participants was 41 (20-64) with two responses left blank and a standard deviation of 11.2
- Average years in logging was 16 (1-40)
- Average equipment age was 2.5 years (0-10)
- 96% (24) reported experiencing at least mild neck or back pain over the previous year
- 80% (20) believed that pain was at least in part related to their work in the logging industry.

# WBV Results

<b>Machine</b>	<b>N</b>	<b>Aeq8</b> Mean (SD)	<b>Hours</b> Mean (SD)
Feller	7	1.04 (0.42)	5.15 (3.39)
Loader	9	0.64 (0.32)	4.37 (2.13)
Skidder	11	1.58 (0.34)	4.85 (2.42)
Skidder*	10	1.49 (0.19)	4.3 (1.68)

\*extreme value removed

- All values exceed the ISO 2631 recommended action limit
- The value for skidders exceeded both the ISO 2631 exposure limit value and the European Union Directive exposure limit value (1.15 m/s<sup>2</sup>)



# Noise Results

- The majority (16 (59%)) of the noise exposures were below the OSHA Action Limit of 85 dBA, with none exceeding 90 dBA.
- Due to the long hours, 19 operators (70%) received more than the ISO EU recommended daily noise dose.

## **Average noise LAeq, Dose, and duration of measurement by machine:**

<u>Machine</u>	<u>LAeq</u>	<u>Dose</u>	<u>Duration</u>
Feller	84.09	135.14	9:17:24
Loader	81.71	110.33	9:34:05
Skidder	83.13	130.66	9:07:07




# Previously reported avg accelerations in skidders/logging equipment

Author(s)	Year	Location of measurement	Machine/driving conditions	Avg acceleration (m/s <sup>2</sup> )			
				Sum	x	y	z
Golsse and Hope	1987	in seat	Skidder/Loaded	-	0.54	0.67	0.95
			Skidder/Unloaded	-	0.75	0.82	1.15
Wegscheid	1994	in seat	Skidder	-	0.82*	1.09*	1.42*
Neitzel and Yost	2003	in seat	All logging machines/normal operation	3.53	1.46	1.4	1.83
Cation et al.	2008	in seat	Skidder/Loaded	-	0.72	0.96	0.72
			Skidder/Unloaded	-	0.86	1.12	0.73
Lynch et al.	2015	in seat	Skidder/Normal operation	1.58	0.83	1.09	0.87
*determined from ranges in figures							

# Quick Comparison

- ▶ Although not able to be directly compared, Neitzel and Yost (2002) looked at several logging tasks and measured noise and whole-body vibration exposures
  - ▶ Measured overall WBV at  $3.53 \text{ m/s}^2$  (Aeq), as compared to the  $1.58 \text{ m/s}^2$  (Aeq8) seen in skidders alone in this study (the highest exposure group)
  - ▶ Measured overall noise exposure at 90.15 dBA (OSHA), whereas there was not a single exposure over 90dBA in this study
- ▶ These differences could indicate improvement in machine design characteristics



# Discussion & Conclusions

- All of the machines in this study had average vibration levels recorded that were either comparable or less than the WBV levels delivered to operators in previous research
- This supports the idea that advancements are being made, but further improvements are still needed
- European countries have already implemented regulations for WBV exposure, and it would be prudent for US manufacturers, owners, and operators to reduce the level of WBV exposure as much as practical



# Concerns

- Do people changing jobs (within logging) over their career mitigate vibration exposure?
- Can skidder vibration be moderated through operator/production expectation?
- Would logging firms implement real ergonomics programs?
  - Checklists, stretching, short breaks, reporting ergonomics concerns
- Will equipment get better, or different?



# Thank you

▶ Questions?

