

# A Process to Calibrate a WIM System, Monitor that Calibration and Determine the Validity of Weight Data

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# Standard method of calibrating a WIM system

- Repeated runs with a test truck of known static weight.
- Calibrate to gross weight.



# Advantages of using test trucks for calibration purposes

- Calibrate the WIM system to a known static weight.
- Repeat visits over time with the same truck, load and load distribution provides a stable common reference point.

# Disadvantages of using only a test truck for calibration purposes

- Significant time lapses between useage, during which time calibration can drift. As a result, there are long periods of time when the calibration status is uncertain and unknown.
- When using a calibration test truck, all one knows for sure is that the scale is properly calibrated to weight that truck and not necessarily traffic stream trucks.

# What other options are available in addition to test trucks?

- Monitor the front axle weights of 5 axle semis.
- Monitor the distribution of gross weight of 5 axle semis or twin trailers.
- Use a combination of test trucks and monitoring the distribution of gross weight of 5 axle semis or twin trailers.
- Other?

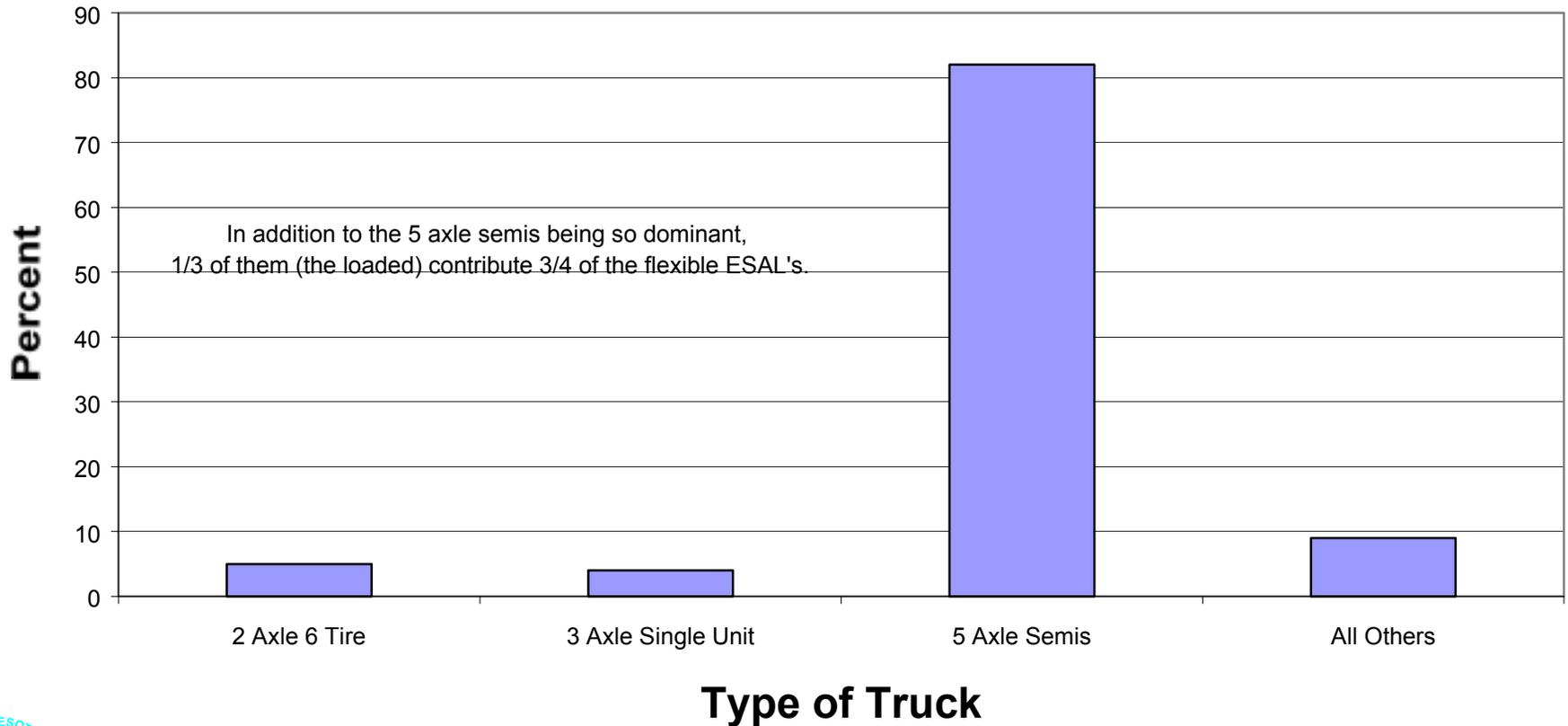


# Why do we focus our attention on 5 axle semis?

- They are the dominant truck on many highways.



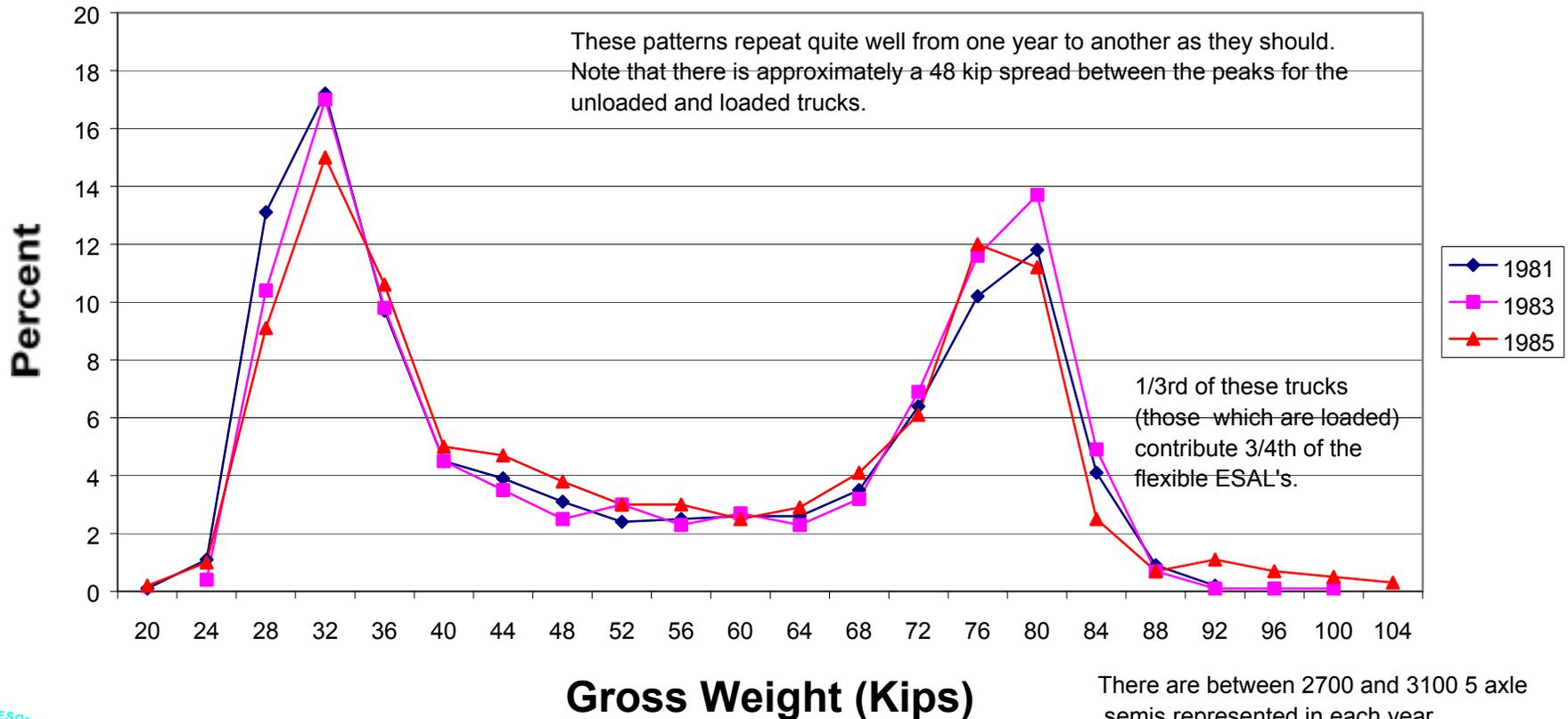
# Percent of Flexible ESAL's Contributed by Various Types of Trucks on Rural Trunk Highways in Minnesota in 1992



# What is the basis for analyzing the distribution of gross weight of 5 axle semis?

- Static weight distributions generally show a bimodal distribution.
- Weights recorded by WIM systems also show this bimodal distribution.
- It provides a stable, generally reliable indication of system calibration.

# Distribution of Gross Weight of 5 Axle Semis based on Static Weights recorded in Minnesota between 1981 and 1985



There are between 2700 and 3100 5 axle semis represented in each year.



# What if test truck and distribution of gross weight are in conflict?

- Check with weight enforcement officers to see where peaks for loaded vehicles occur.
- Examine static weight data, even if it is fairly old.
- Check where peaks are occurring for:
  - Other lanes at the same site.
  - Other sites on the route or on a similar route.

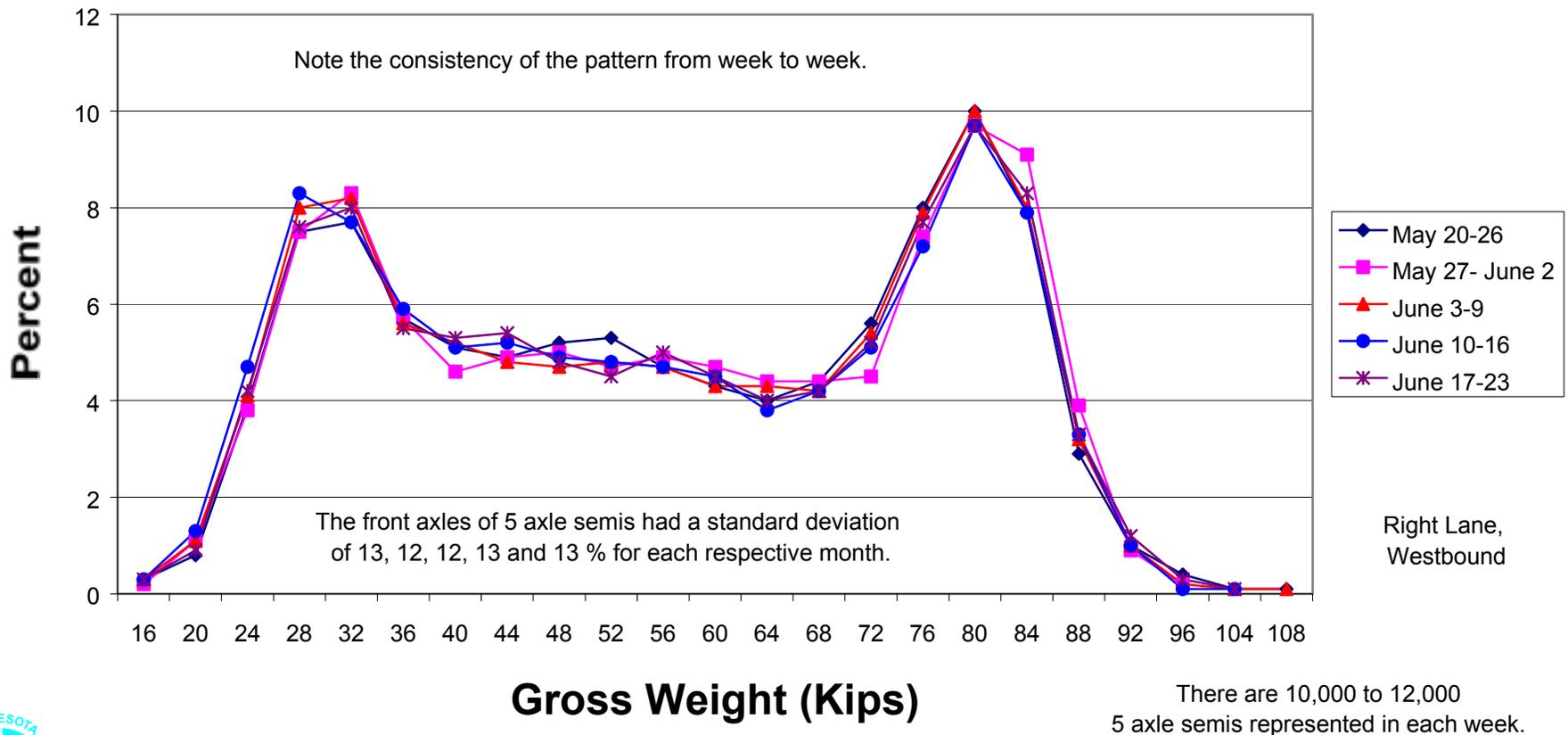
# What are the advantages of monitoring the distribution of gross weight?

- The data regularly collected by the system itself provides an indicator as to us how well it is functioning. An external check such as a test truck is not always needed.
- It enables the monitoring of system performance on an ongoing, continuous basis. This is in contrast to a test truck which might provide this information every 6 months.

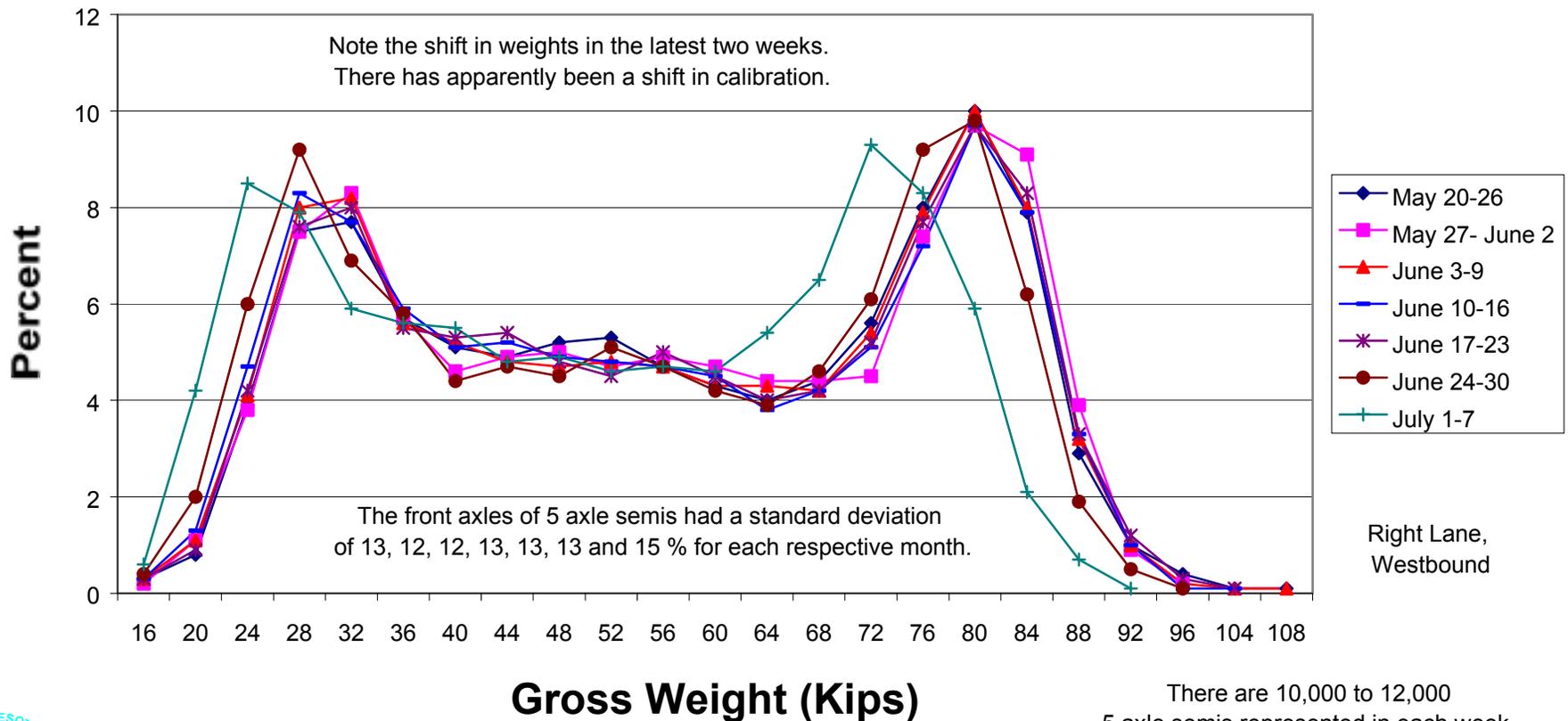


# Examples showing the distribution of gross weight of 5 axle semis

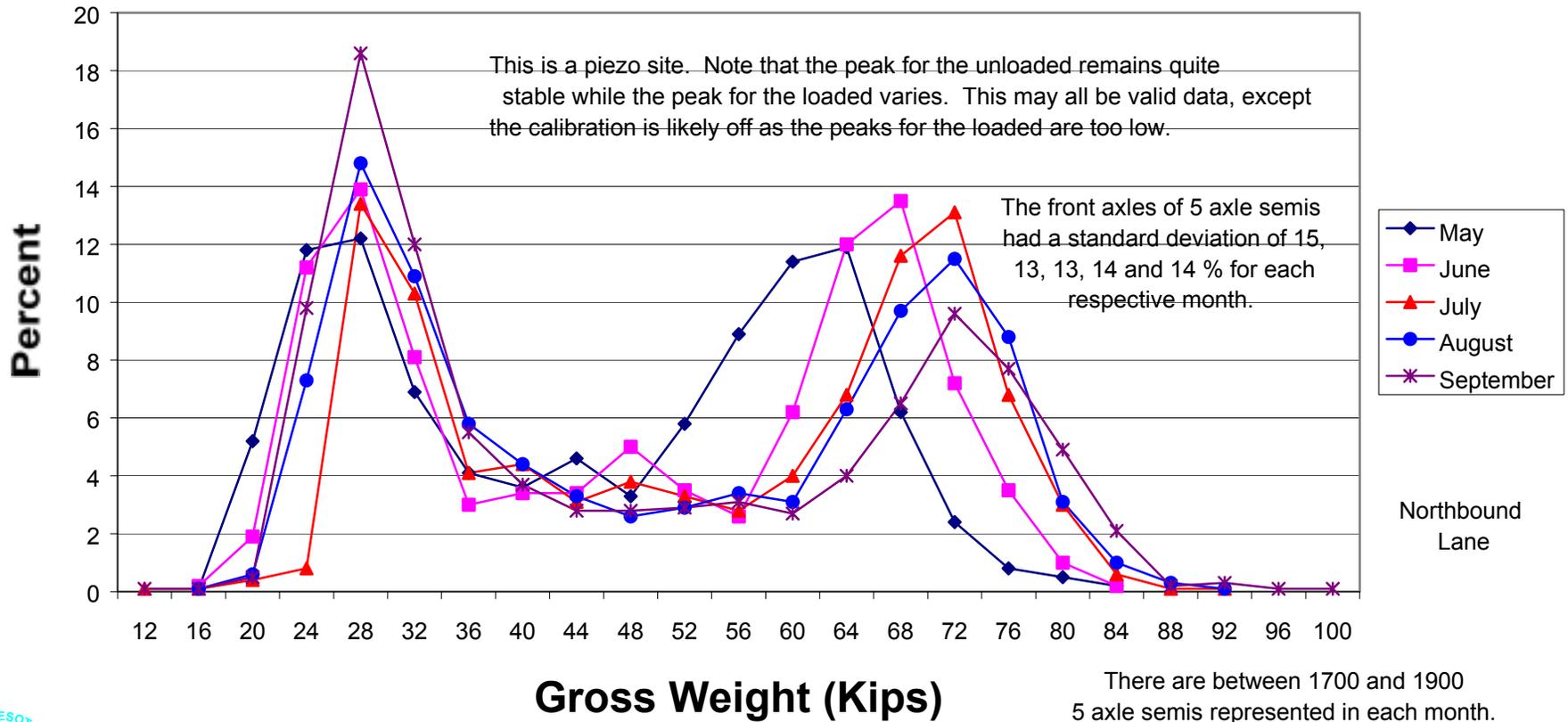
# Distribution of Gross Weight of 5 Axle Semis as recorded for 5 consecutive weeks at the I-94 (MnROAD, IRD) WIM in Minnesota in 2001



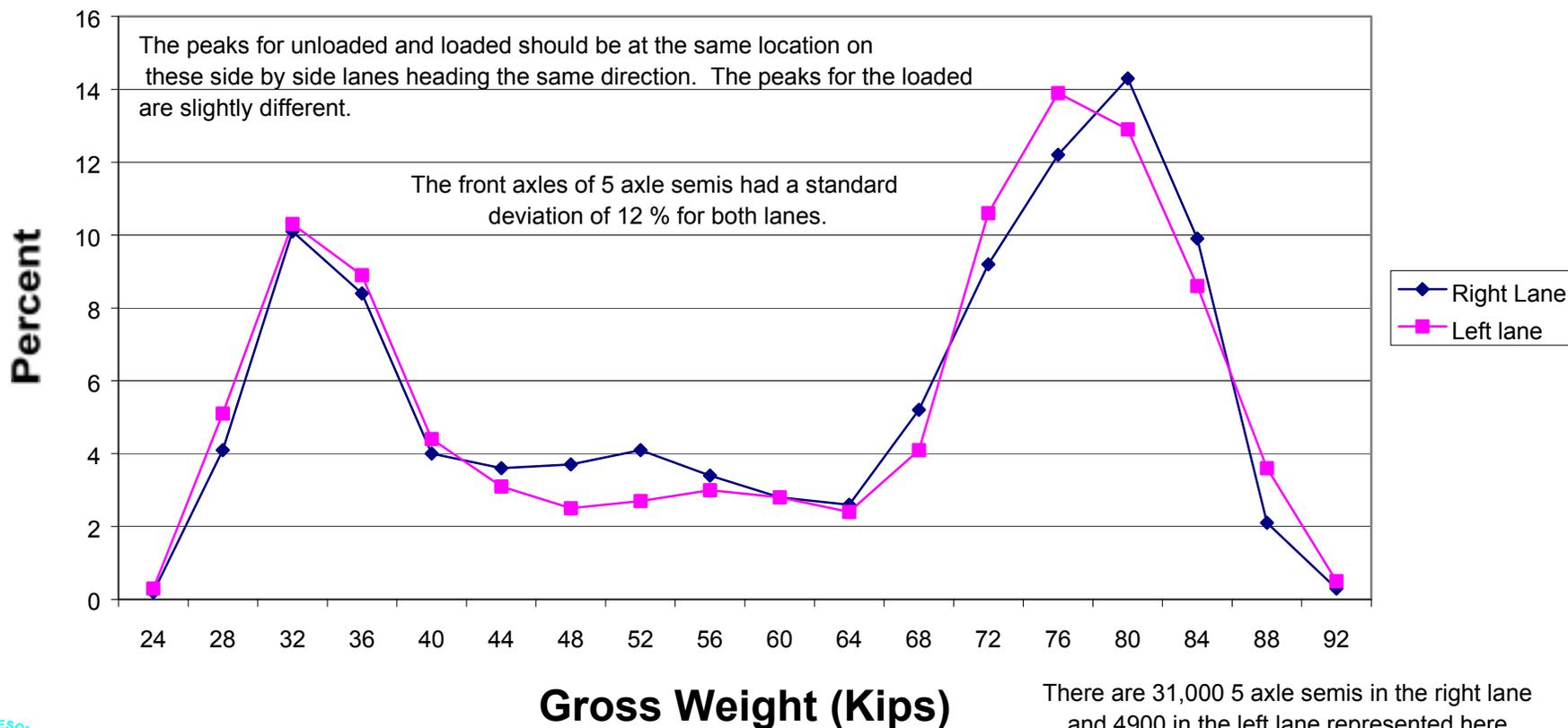
# Distribution of Gross Weight of 5 Axle Semis as recorded for 7 consecutive weeks at the I-94 (MnROAD, IRD) WIM in Minnesota in 2001



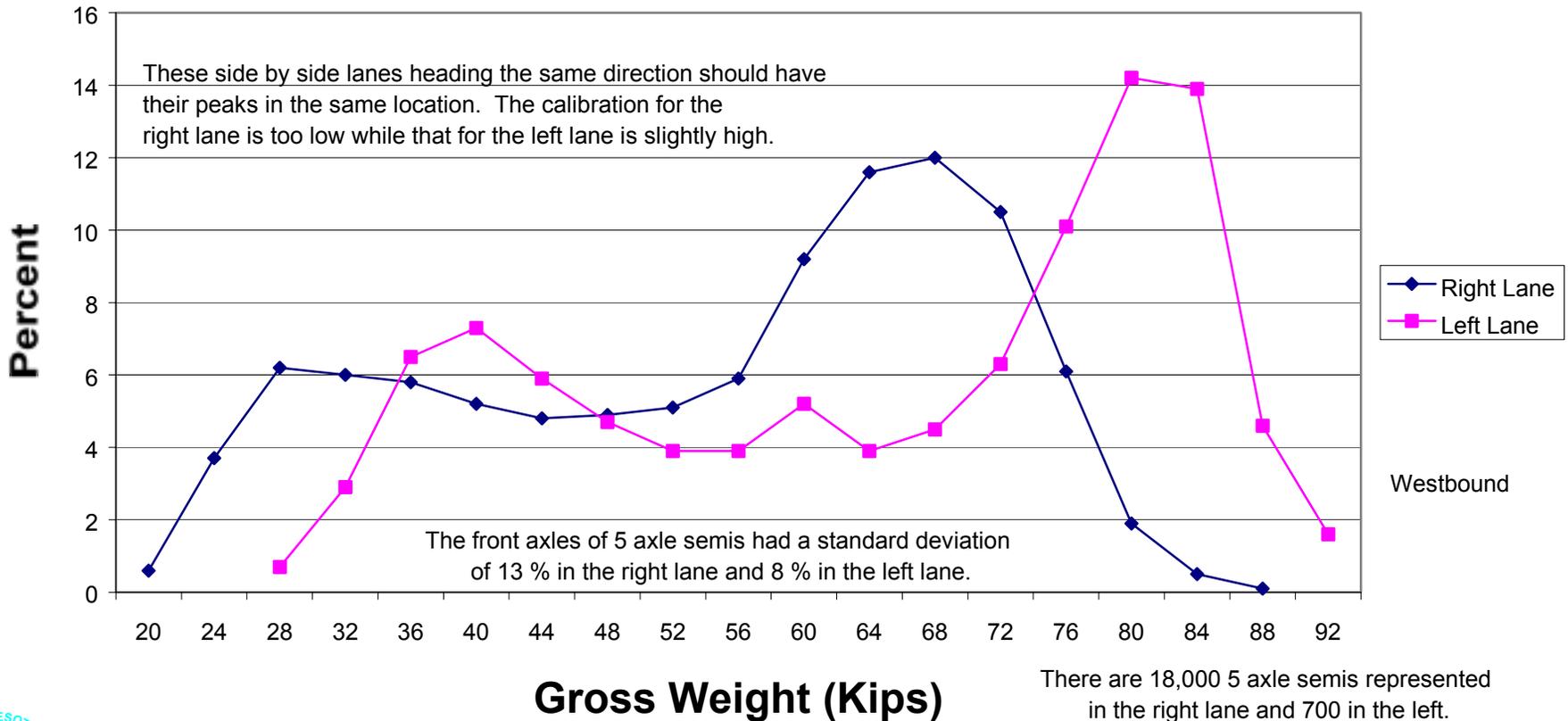
# Distribution of Gross Weight of 5 Axle Semis as recorded for 5 consecutive months at the TH 71 (Olivia) WIM in Minnesota in 1992



# Distribution of Gross Weight of 5 Axle Semis as recorded for one month at the I-94 (Clearwater) WIM in Minnesota in August 1992



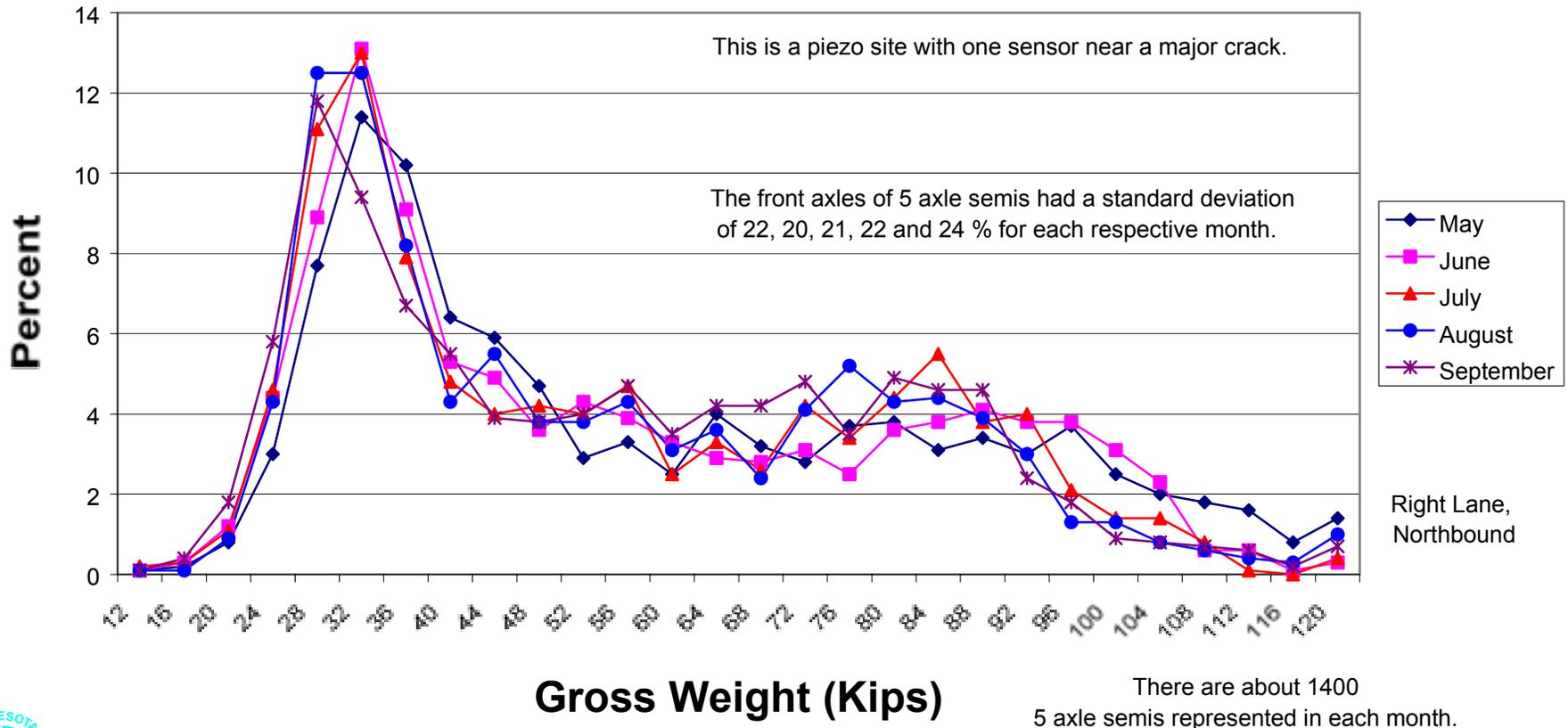
# Distribution of Gross Weight of 5 Axle Semis as recorded for one month at the I-90 (Winona) WIM in Minnesota in 1998



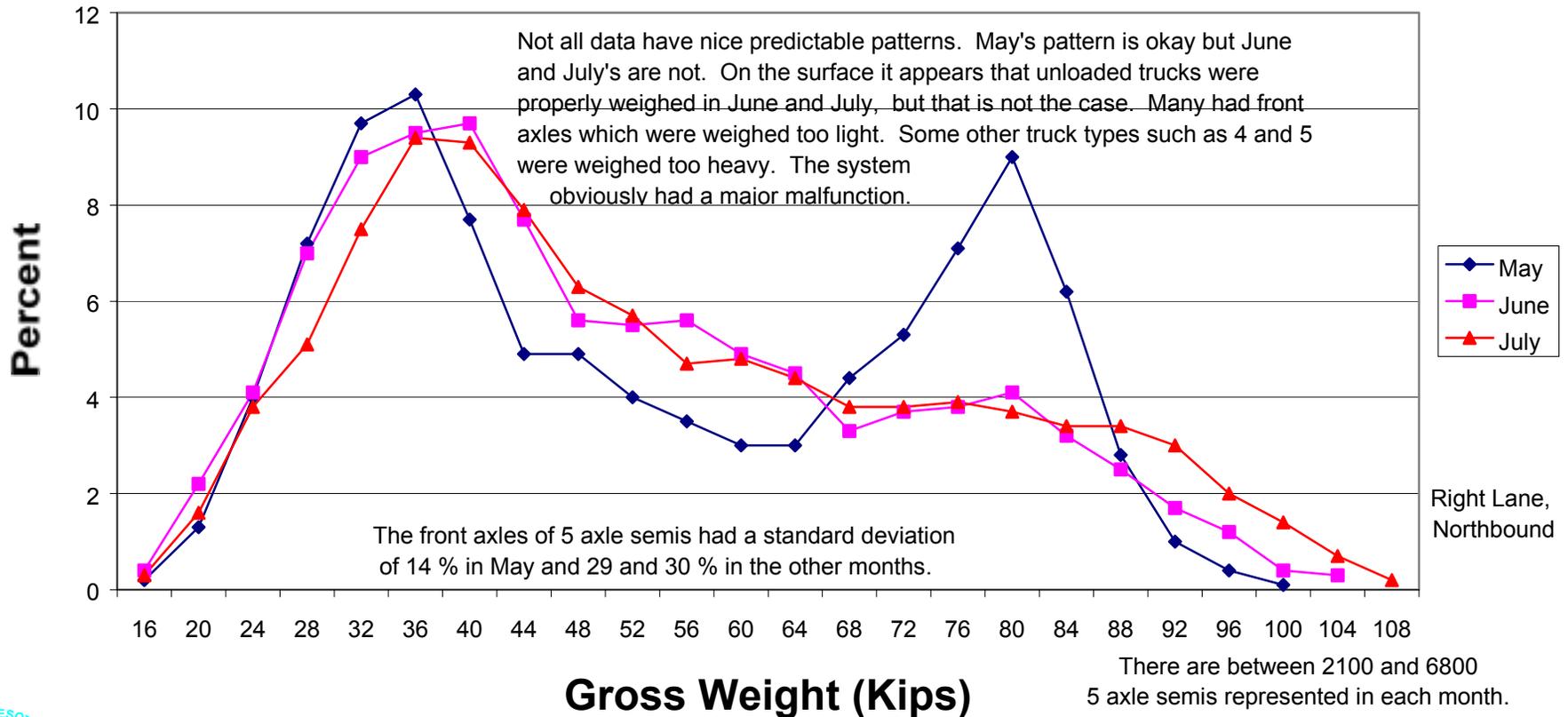
Westbound



# Distribution of Gross Weight of 5 Axle Semis as recorded for 5 consecutive months at the TH 65 WIM in Minnesota in 1992



# Distribution of Gross Weight of 5 Axle Semis as recorded for 3 consecutive months at the I-35E WIM in Minnesota in 1997



# What does analysis of WIM data using the distribution of gross weight of 5 axle semis show?

- Most sites have the bimodal distribution with one peak for unloaded and a second peak for loaded, which is the same as we see with static weight data.
- A few sites have only one prominent peak due to trucks being loaded in one direction and unloaded in the other.



# What else does it show?

- Most of the time when peaks shift, both peaks shift in the same direction and by about the same percentage. This indicates a shift in calibration.
- Occasionally, one peak will shift but the other will not. This likely indicates a change in weights which is real.

# What else?

- Most shifts in peaks are relatively small, being under 10 %.
- Large shifts in peaks may indicate a system failure and not simply a shift in calibration.
- If peaks shift in opposite directions, it indicates a system failure.

# What else (side by side lanes)

- Side by side lanes heading the same direction should have their peaks at the same place. The height of the peaks may vary, but the placement should not.
- If there is any movement in the peaks, it should take place in both lanes and in the same proportion. If it takes place in only one lane, chances are there is a problem with that lane.

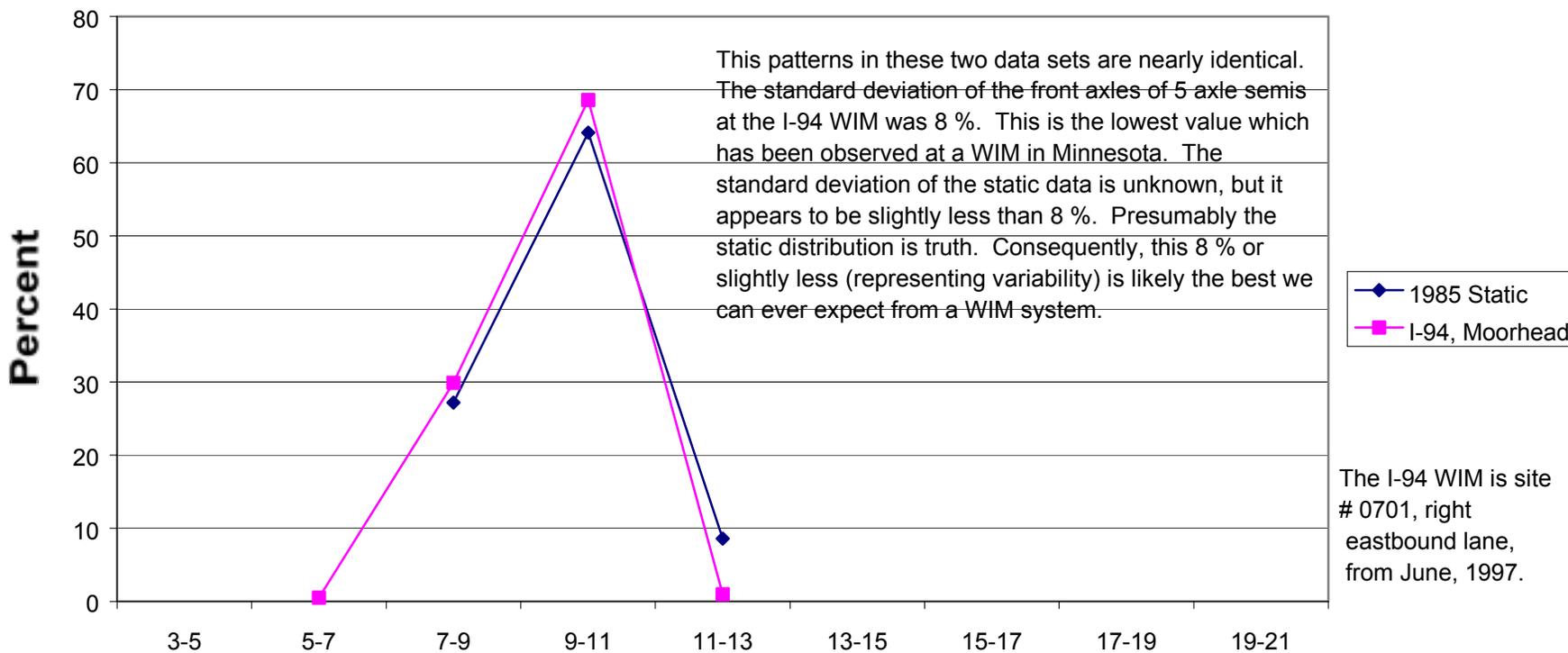
# What other procedures can be used to monitor a system's performance?

- Monitor the variability of the weight data.
  - Need weight distributions adequate to meet the needs of mechanistic empirical design.
  - Need to collect top quality data if at all possible.

# What data do we use in analyzing the variability of weight data?

- The percent standard deviation of the weight on the front axles of 5 axle semis.
  - These values remain stable over time as long as the calibration remains constant and as long as the system is properly functioning.

# Distribution of the Front Axle Weight of 5 Axle Semis as Recorded Statically and at one WIM in Minnesota



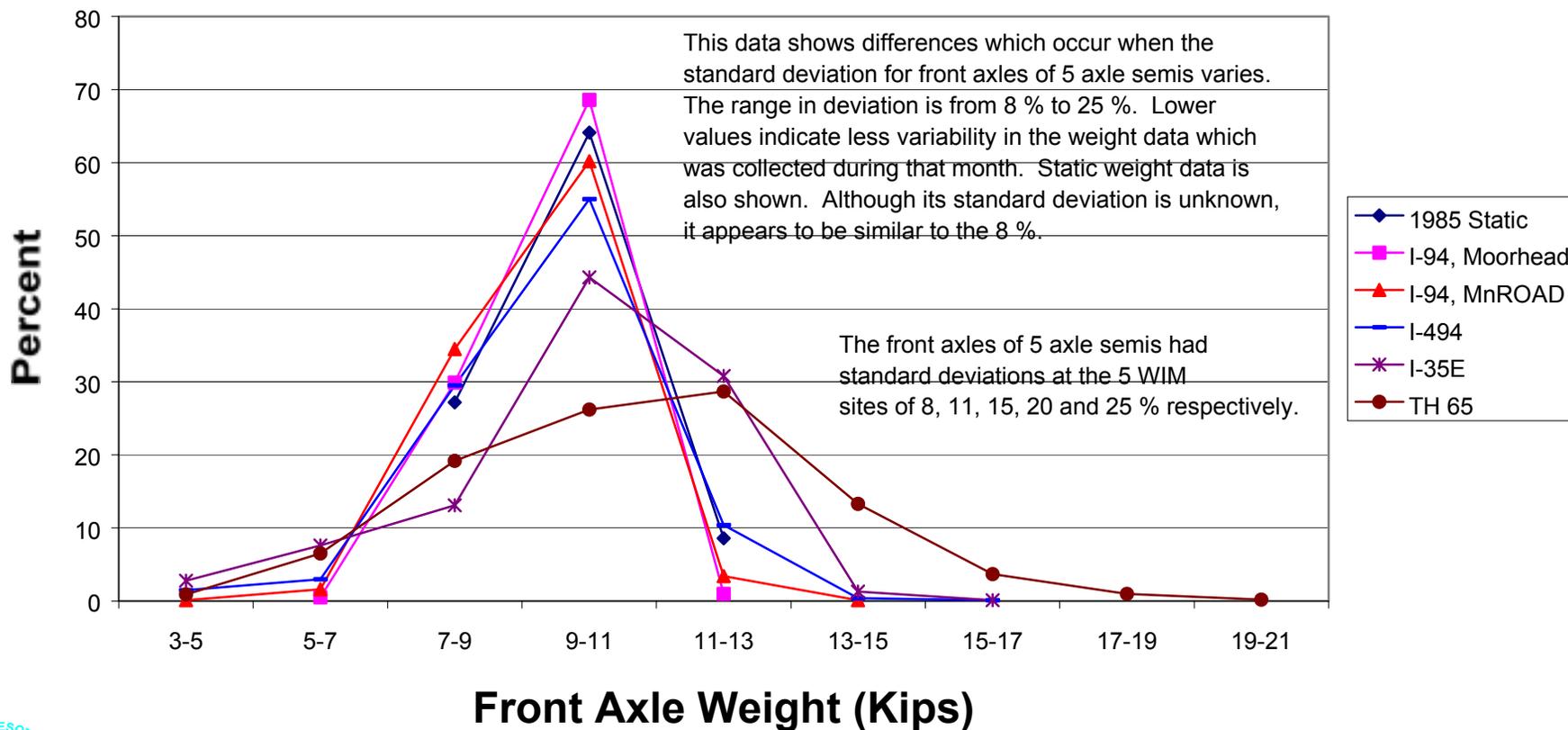
The I-94 WIM is site # 0701, right eastbound lane, from June, 1997.

**Front Axle Weight (Kips)**

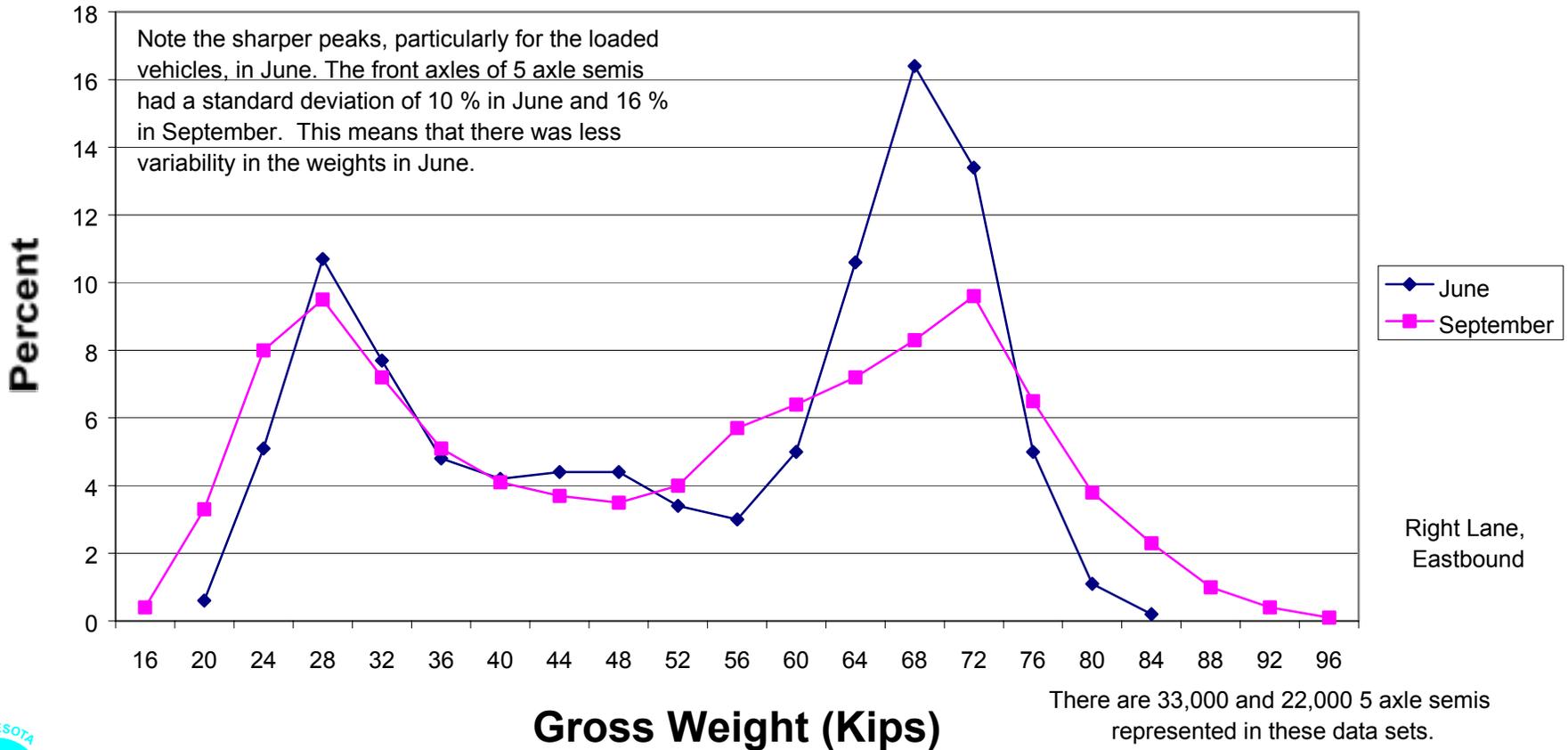
There were 3100 front axles weighed statically in 1985 and 15,000 at the I-94 WIM.



# Distribution of the Front Axle Weight of 5 Axle Semis as recorded at 5 WIM sites and statically in Minnesota



# Distribution of Gross Weight of 5 Axle Semis as recorded for 2 months in 1997 at the I-94 (Clearwater) WIM in Minnesota

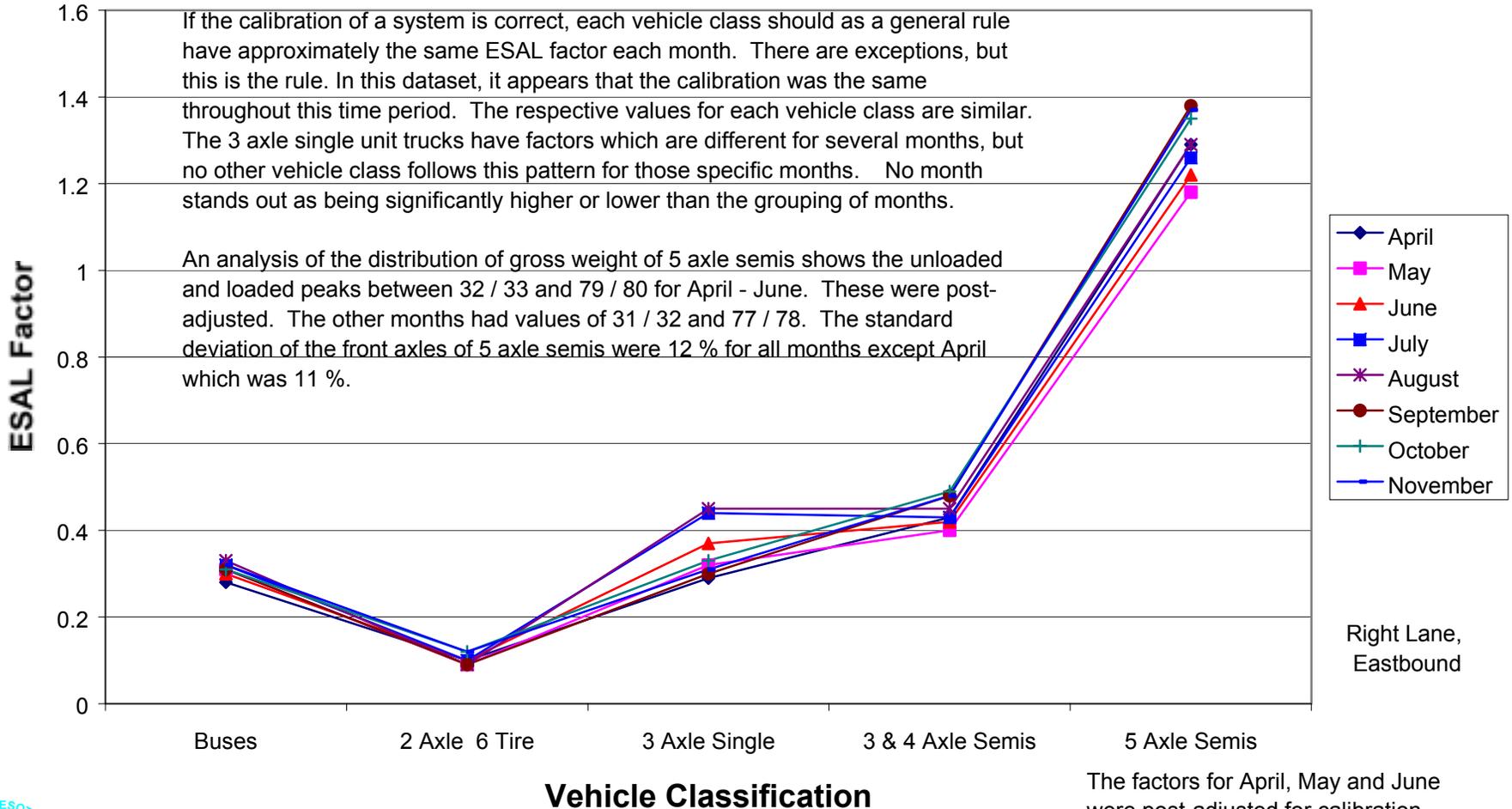


# How else can one monitor relative changes in calibration?

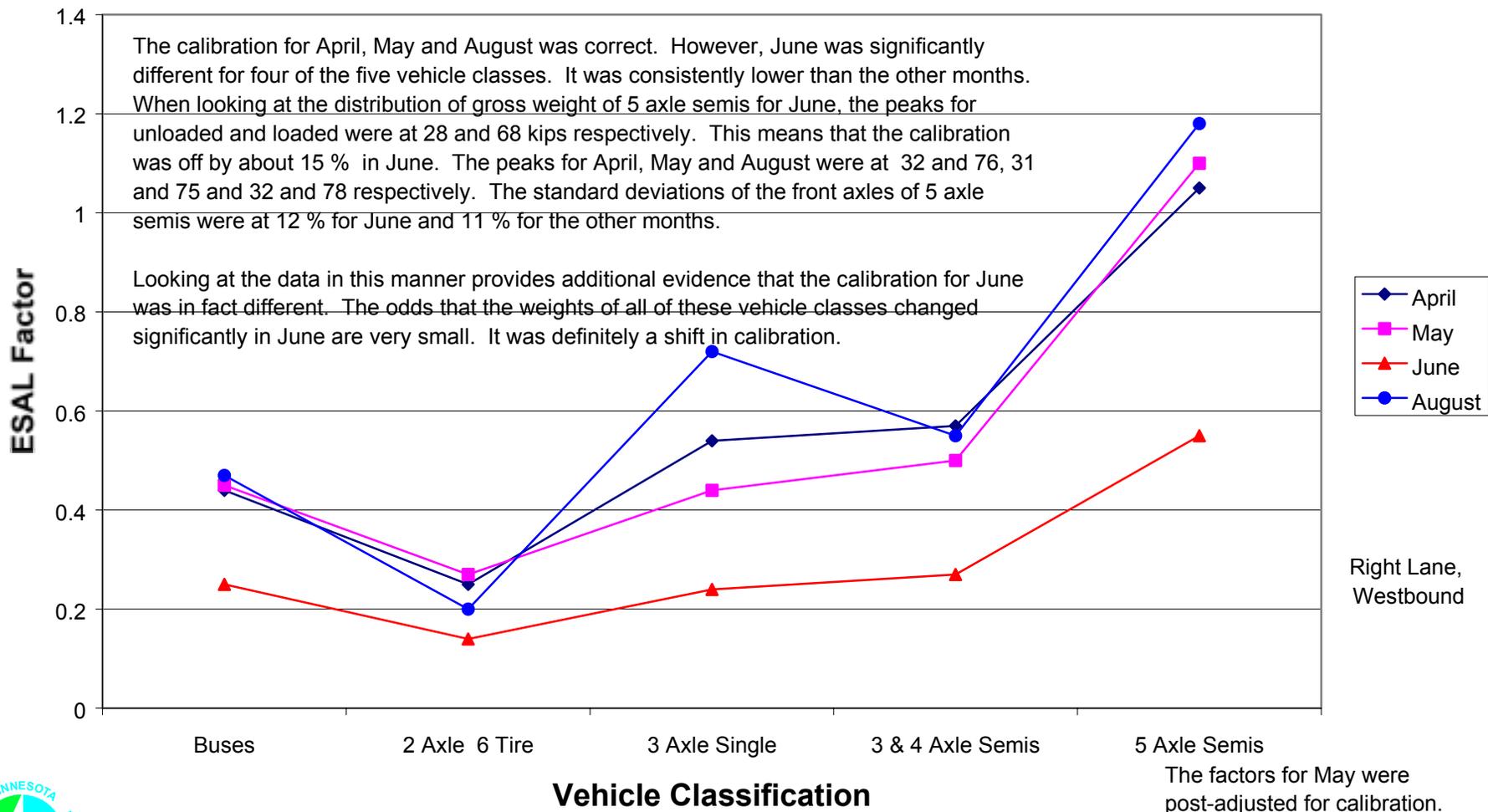
- Examine ESAL factors of selected major vehicle classes.
  - If the factors are similar, it is probable that the calibration is correct.
  - If the factors are consistently higher or lower, it is probable that the calibration is off.



# Flexible ESAL Factors for Selected Truck Types as Recorded at the I-94 (Clearwater) WIM in Minnesota in 1992



# Flexible ESAL Factors for Selected Truck Classifications as Recorded at the I-94 (Mn/ROAD) WIM in Minnesota in 1997



# What useful information do we obtain when monitoring ESAL factors of selected trucks?

- It provides additional evidence regarding the calibration of a WIM system.
  - Similar ESAL factors over time tend to indicate that the system is properly calibrated.
  - Factors that have changed may indicate a change in calibration.
- Base of knowledge is broadened by including trucks other than 5 axle semis.



# Additional items which should be monitored

- Axle spacing of the drive tandem on 5 axle semis.
- Percent of invalid vehicles.
- Percent of miscellaneous vehicles.
- Abnormal number of light or heavy trucks.
- Speed distribution.
- Other?



# What is the state of how well we calibrate WIM and validate data?

- It is far from being a science.
- There are some things which we can discover and use.
- We need to take advantage of the “bits and pieces” which are available. This will allow us to better assemble a complete package.
- We are still in the process of discovery.



# Conclusions

- One needs to have a series of processes which are worked together with one another.
- No one part of the process can definitively indicate how well a system is performing.
- An ongoing monitoring and analysis of traffic stream data collected by WIM is a necessity.

