Standardizing and communicating animal crowding on vehicles

Terry Whiting
Office of the Chief Veterinarian
Manitoba, CANADA
Describing “Crowding”

- Presume - overloading is a significant cause of poor animal welfare
- Laws - have been written in several jurisdictions to proscribe maximal crowding during Transport
- Codes of Practice - make recommendations as to maximal crowding of animals during transport

• We care about crowding in animals in transit because there is a tremendous incentive to crowd animals in land transit and the science is pretty convincing that crowding leads to poor welfare.
I would like to nominate this page as an example of unconscionable incompetence in scientific editorial of any publication in Humane Transport or animal Welfare.

This huge table of numbers can be calculated from about 6 numbers by any child who has successfully completed Grade 5 math.

Agriculture Canada Hang your head in SHAME!
• Crowding in transit adversely effects livestock, as measured by cortisol levels; bruise score; frequency of struggling to maintain footing; and number of falls (3-6).

• The ability of livestock to change position within the group decreases with increased crowding and may prevent livestock from facing the preferred direction during transport (6).

• The behavioral response of livestock to serious overcrowding has been well described. When critical overcrowding occurs, individual animals become recumbent on the vehicle floor and struggle or are unable to regain their footing without the removal of some of the group. This has been described for cattle (4, 5) and horses (8).

• The situation has been described as going down underfoot (5), closing over (7), or involuntary recumbency (8).

• The domino effect, where an involuntary recumbent individual destabilizes the footing of standing compartment mates, has also been described for cattle (5).


How do we describe “crowding” in transport

- How has it been done?
- How could it be done?
- What has worked for us.

• Describing minimum space allowance requirements for cattle in transit has proven to be difficult, as the space required increases as the animal grows.

• Loading pressure, defined as weight of live animal per unit area, has proven to be a clear method of communicating with transporters and inspection staff what the maximum safe stocking limit is based on individual animal weight.
Randall established that there was a mathematical relationship between animal size and space requirements.

As animals increase in size, their weight increases as a function of their length-cubed ($L^3$), while the floor space they require increases as a function of their length-squared ($L^2$) (11).

On a weight per unit area of trailer floor, fewer kilograms of feeder calves than of market cattle can be loaded. There is a curvilinear mathematical function that accurately describes the relationship of floor space required in transit and body weight of any phenotype of bovine animal in a standard level of finish.

This mathematical relationship is not known with a high degree of certainty at this time. However, graphical representation of numerical information can serve as an instrument for reasoning about quantitative data (13).

• In the development of the now universally utilized gestation crate there was a great deal of research into the minimum space an animal needed to lie down and stand up.

• This research on individual animal housing is difficult to apply to group loaded animals and was done only for swine in any comprehensive way.

• What is shown in this diagram is that if you convert weight to weight$^{2/3}$ then the continuous function which describes space requirements becomes a straight line.

• The lower line is for sternal recumbency and to lie in lateral recumbency the pig needs more floor space (Upper line).
The relationship between stocking density and average weight of pigs per pen according to equation \( A=0.03W^{0.67} \) dashed line and according to EU Directive 91/630 (top of the bars).

- Regulators on the other hand are dominated by the legal profession.
- Lawyers appear to be numerically impaired other than when it comes to charging fees by the hour.
- This diagram describes the weight range and space allowance required by the EU directive controlling method of production of swine in confinement (top of the solid bars).
- The bars are an administrative approximation (written into law) of the scientific recommendation which is the dashed line.
- A problem may arise when written regulations use a stair step approach in relation to space allowances.
- Enforcement may actually be more difficult if the judiciary perceives that, at least some aspect of the application of the law is senseless; for example where a small increase in body weight requires a disproportionate increase in space allowance.
-
<table>
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<tr>
<th>Weight (kg)</th>
<th>Area Density (kg/m²)</th>
<th>Pressure Density (kg/m²)</th>
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Density = 33.3W^{0.33}

Read Area line on the Left. The same recommendation displayed as a “Pressure” shows greater curvature. Emphasize the additional space required for light weight animals.

- A alternative way of looking at space allowance/stocking density is loading pressure. (Density is actually mass/volume and we are measuring mass/area which is pressure in English)
- “Space allowance” is the intuitive way of approaching the loading density problem from the animals point of view
  - and “loading pressure” is the intuitive way of looking at the loading density problem from the trucks point of view.
- Truckers are always attempting to maximize the axle weight of their vehicles and thus be the low cost hauler.
- In this chart the same tabular recommendation is plotted two different ways.
- The data is from the EU standard for living space for confinement hogs (Dashed line from the previous slide).
- The data is described by a power function either way, however; in comparison to area required, the density function has greater curvature especially as the average weight of animal decreases.
- Errors in loading are often made with smaller calves and young horses when the trucker is attempts to load a “truck full” based on total loaded weight.
Example:
Create a pressure diagram
From this Data

- To think about what is reasonable space allowance for horses in transit and show the application, we can Evaluate this reference, as the authors have described a nice spread of animal weights and space allowance recommendations.
• Converting the space allowance into loading pressure by dividing the area by the maximal weight in the stair-step, gives a series of maximal pressure points which can be fitted with a power function.

• Presenting the data like this shows that the last point on the right derived from (800 kg @1.73 m²) may be an outlier slightly, but; in general the data has excellent fit.

• The power formulae approximation is used as Randall suggested from a theoretical considerations that maximal safe pressure should conform to a power function.
PMU - Project (Real Data)

- Brandon Manitoba is the location of the Ayerst-Organics production facility for Premarin
- Every year 30-40,000 foals are produced in the PMU industry
- From 1995-1997 foal sales were monitored and trailers inspected

- The EU recommendations by air were not known (by us) at the time that Agriculture Canada initiated a project to look at loading pressure as currently is the practice for horses hauled en masse in Canada.
- Inspectors collected data on loads they routinely inspected in a way which allowed for the calculation of pressure in the truck or trailer.
  - Area - # horses - average mass & do the math
Possum Belly Trailer
Foals in the top deck

Grey Day in Manitoba
Import Slaughter Horses

- In 1997 a National initiative to inspect import slaughter horses was carried out
- Information from these two studies were the basis for creating a Predictive formulae for maximal loading pressure (mass/area) for land transport

- Data from Quebec was used as NY-State prevents the double decking of horses and the inspection was far simpler than in 5 or 6 compartment possum belly trailers as used in Western Canada.
• At the time of the study there was no Code of Practice for transporting Horses in Canada.
• At the low animal weight (PMU Foal Sales) there were observations made consistent with overcrowding at the high loading pressure (involuntary recumbency and head bruising). One farm may market 100-200 animals or more on the same day using one 30-horse loose trailer to deliver them to the auction.
• The very heavy horses were reported to have “ample room” at the pressure recorded by the veterinarian assembling them.
• Remarkably in the group of horses for slaughter the truckers were of the opinion that their loads were generally full however, when plotted they were aware of obligatory veterinary inspection at the border and may have been conservative in their loading enthusiasm.
SO

- Pretty sure the 1987 EU horse standard is appropriate for land and air
- Can we enforce stair-step regulations?
  - Probably not in Canada
- Continuous function is probably a better way
  - Space or Pressure which is best

- It is quite remarkable that a freehand approximation made independently of the EU horses by air would agree almost 100% for maximum loading pressure
  - Pretty sure this is a good standard.
- Can we enforce stair stepping in Canada - no! In our experience prosecutors won’t prosecute that method of describing thou shall not exceed this limit. To my knowledge Agriculture Canada has never prosecuted on the basis of overloading, although overloading is forbidden.
Both on the Same Graph = Confusing?

- It is possible to graph both Minimum space per animal (lower line Left axis) and maximal pressure (red line Right Axis) on the same graph.
- The result is a bit info intense for the average user.
- Graphing them on the same page does demonstrate that the Pressure line is more sensitive to the increased space requirements of the young of a species when based on individual weight. Line curves sharply at low animal weight.
• This is a comparison of three very similar recommendations.
• This is the minimal space allowance graph.
• It is tough to detect where the recommendations disagree as from 100 to 500 Kg there is almost complete agreement.
• this is the same recommendations only displayed as maximal pressure guidelines.
• This method of display is more sensitive to the very small differences in these three recommendations.

From Whiting CVJ 2000

Table 2. Maximum trailer floor pressure (kg/m²) for cattle transported by road, calculated on an individual animal weight basis; comparison of recommendations* from 8 authorities

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*Values are the maximum pressure compatible with the recommendation, calculated by dividing the point space value by the maximal limit of the weight range. The result is an (kg) coordinate on the pressure vs body weight Cartesian plot.

*European Conservation Institute recommended loading density for horned or horned cattle, or if more than 10% of the load is horned or tipped.

*Canadian Maximum Regulations indicates a minimum space allowance.

*Council of European Ministers of Agriculture indicates the figures are considered to be satisfactory when cattle without horns are being transported by road.

*Australian data was derived from combining 2 tables in the original document including old recommendations and more cattle without horns.
Load Arrived in Winnipeg Aug 7, 98.

Full Rail 1077 feet$^2$ @ 60 lb./ft$^2$ = 64,620 lb.

242 (270 lb) pigs loaded, 234 arrived alive 65,340 lb.

overall trailer length 53 feet

X = 1 dead hog

TRUE STORY

Practical Application

- When inspecting a load of animals, the total weight and the number of animals are known from the manifest, so the average animal weight can be calculated.

- “FullRail” means the whole of the belly was a triple deck. This trailer had 1077 sq feet. (sorry about the Imperial we are bi-lingual in Canada).

- In Canada and the United States, the external dimensions of road vehicles are controlled by highway transport safety regulations in imperial units.

- Canada and the United States have harmonized to a standard maximum allowed external width of 2.59 m (102 in).

- The length of each compartment can be measured from the outside of the trailer and the area calculated by using the internal width as 2.53 m (manufacturer claim 99 7/8 in).

- By knowing the number of animals per compartment and their average weight, the pressure as weight per unit area is easily calculated from a god inspection report at the time of the disaster.
Overcrowded For Aug. 7th?

Max Pressure in the Code 60 lb./sq. ft
“Don’t Use Tri-axles for pigs?”

- In this example the compartment holding the dead pigs had been loaded at 76 lbs/sq foot when the maximum recommended in temperate weather is 60.
- Pigs however are very smart and actually were dying to achieve this stocking density.
- 30 living pigs in this compartment 30X270=8,100 lbs and 128 Sq.Ft is 63.2 lbs/sq foot so they almost achieved the recommended maximal loading density by just dying back to the right number.
- You just can’t outsmart those pigs.
Foals Saskatoon 1997

36 foals @ 490lbs = 17,640 lbs.

Area 8.3X27=224 sq. feet  Pressure 17,640/224=79 lbs/sq
Recommended maximum 55 lbs/sq foot if >8 hours

- Trucker was not prosecuted for overcrowding as the crown found the wording of the federal regulations unclear and there were no objective recommendations for loading pressure.
- Did get a conviction on failure to provide veterinary care. ($5,000.00 I think)
- I did this picture from memory, and did not do the inspection myself. I ma sure of the 36 loaded and 6 DOA and the weights as I had that in my diary.
- Horses are just as smart as pigs 30X490=14,700 divided by 224 sq feet = 65.5 lbs/sq ft. Quite close to the recommended maximum.
- I would not write a research grant using this method of determining what the actual maximum loading pressure is. Most Animal Care Committees would have a problem with this project design.
• If you graph the 80 lbs/sq.ft with a 490 pound foal on the maximal pressure chart it is easy to recognize (even to a Crown prosecutor) that the compartment was overloaded.
**Evaluate a Standard**  
**Example 2**  

**Source**  
http://www.grandin.com/behaviour/rec.truck.html

<table>
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<th>Feedlot Fed Steers or Cows, Avg. Weight</th>
<th>Horned or Tipped or more than 10% Horned and Tipped</th>
<th>No Horns (pulled)</th>
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<td>English / Metric Units</td>
<td>English / Metric Units</td>
<td>English / Metric Units</td>
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<td>800 lbs (360 kg)</td>
<td>10.90 sq.ft. (1.01 sq.m)</td>
<td>10.40 sq.ft. (0.97 sq.m)</td>
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<td>800 lbs (360 kg)</td>
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<td>1400 lbs (635 kg)</td>
<td>19.00 sq.ft. (1.76 sq.m)</td>
<td>18.00 sq.ft. (1.67 sq.m)</td>
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- Small weight range 800-1400 pounds  
- Large steps 200 pounds  
- Low number of points to evaluate n=4

- Non essential slide Skip if time is short.
Nonsense Recommendation

Temple Grandin Beef Horned

- Non essential Slide  BULLSHIT DETECTION
- You can hide this slide
- Another useful byproduct of graphing tabular recommendations as a function is you can recognize recommendations which fall outside the generally accepted principles of science as this one does.
- This recommendation is crap even before you compare it to other sources
  - It does not follow the assumed to be correct power function format where larger animals can safely be hauled at a higher loading pressure.
- General rule: the numerically impaired should not make loading standard recommendations (Send that the veal code committee).
Pressure (Mass/Area) Preferred

- Preferred from truck side inspection standpoint
- More discriminating visually from the same recommendation depicted as a minimal space
- Good to detect errors in recommendations or nonsensical standards

Truckers Choice

- The unit of measurement truckers would prefer is
  - Animals of average weight X can not be loaded at more than Y pounds/running foot of deck
  - Almost all trucks are 8.3 ft Internal Width
  - Market Pigs at 60 lbs/sqfoot = 60*8.3 = 498 pounds/running foot of deck
Conclusion

- It is possible to compare differing recommendations in an objective way
- Publish standards can be objectively evaluated
- The use of stair step recommendations should be discouraged in law and in codes

Conclusion - cont.

- In application, when describing minimal space allowance for animals in transit, graphical recommendations based on maximal floor pressure for all weights in the range are a useful way of thinking about stocking density.
References


The End