Comparison of Methods for Estimating Poultry Manure Nutrient Generation in the Chesapeake Bay Watershed

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The Chesapeake Bay Watershed

EPA Modeling the Impact of the Food (Poultry) Industry

- EPA is using data from the late 1980's and early 1990' to estimate Nitrogen and Phosphorous generation from agriculture and food production systems.

- Key questions:
  - What are the current predictions by the EPA model?
  - What would the model predictions be if modern data were used?

Water Quality Indicators
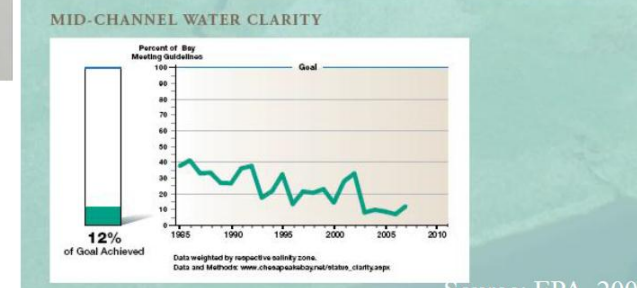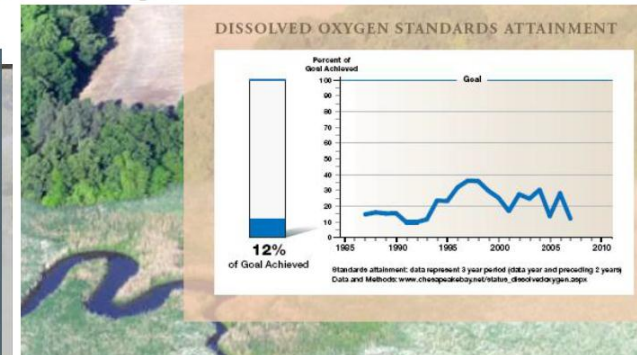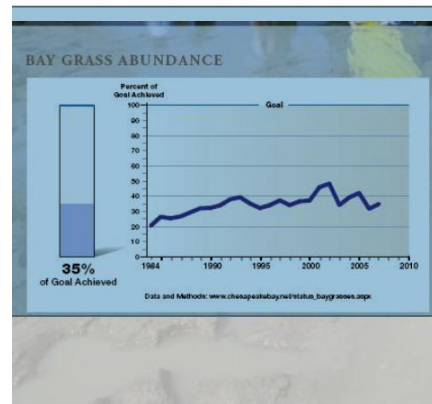
Key Environmental Parameters
- Nitrogen
- Phosphorous
- Sediment (Erosion)

The Poultry Industry

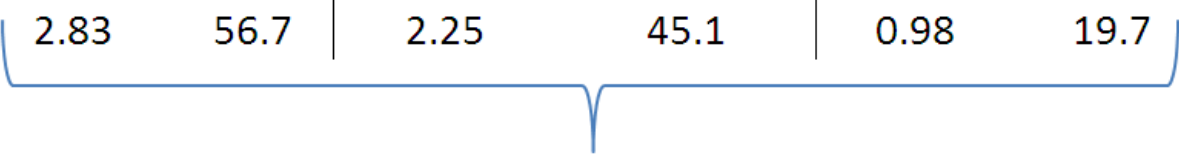*Production, Processing, and Consumption*

ASAE Standard, 2003

Table 2 – Fresh manure production and characteristics per 1,000 lb live animal mass per day

Parameter	Units*		Dairy	Beef	Veal	Swine	Sheep	Goat	Horse	Layer	Broiler	Turkey	Duck
Total manure‡	lb	mean§	86	58	62	84	40	41	51	64	85	47	110
		std. deviation	17	17	24	24	11	8.6	7.2	19	13	13	**
Urine	lb	mean	26	18	**	39	15	**	10	**	**	**	**
		std. deviation	4.3	4.2	**	4.8	3.6	**	0.74	**	**	**	**
Density	lb/ft³	mean	62	63	62	62	64	63	63	60	63	63	**
		std. deviation	4.0	4.7	**	1.5	4.0	**	5.8	2.4	**	**	**
Total solids	lb	mean	12	8.5	5.2	11	11	13	15	16	22	12	31
		std. deviation	2.7	2.6	2.1	6.3	3.5	1.0	4.4	4.3	1.4	3.4	15
Volatile solids	lb	mean	10	7.2	2.3	8.5	9.2	**	10	12	17	9.1	19
		std. deviation	0.79	0.57	**	0.66	0.31	**	3.7	0.84	1.2	1.3	**
Biochemical oxygen demand, 5-day	lb	mean	1.6	1.6	1.7	3.1	1.2	**	1.7	3.3	**	2.1	4.5
		std. deviation	0.48	0.75	**	0.72	0.47	**	0.23	0.91	**	0.46	**
Chemical oxygen demand	lb	mean	11	7.8	5.3	8.4	11	**	**	11	16	9.3	27
		std. deviation	2.4	2.7	**	5.3	2.5	**	**	2.7	18	1.2	**
pH		mean	7.0	7.0	8.1	7.5	**	**	7.2	6.9	**	**	**
		std. deviation	0.45	0.34	**	0.57	**	**	**	0.56	**	**	**
Total Kjeldahl nitrogen‖	lb	mean	0.45	0.34	0.27	0.52	0.42	0.45	0.30	0.84	1.1	0.62	1.5
		std. deviation	0.096	0.073	0.045	0.21	0.11	0.12	0.063	0.22	0.24	0.13	0.54
Ammonia nitrogen	lb	mean	0.079	0.086	0.12	0.29	**	**	**	0.21	**	0.080	**
		std. deviation	0.083	0.052	0.016	0.10	**	**	**	0.18	**	0.018	**
Total phosphorus	lb	mean	0.094	0.092	0.066	0.18	0.087	0.11	0.071	0.30	0.30	0.23	0.54
		std. deviation	0.024	0.027	0.011	0.10	0.030	0.016	0.026	0.081	0.053	0.093	0.21

DDA Lab Analysis of Poultry Manure
2005 through 2009

Year	No. Samples	Total N		Phosphate (P2O5)		Total P	
		%	lbs/ton	%P2O5	lbs P2O5/ton	% P	lbs P/ton
2005	462	2.93	58.6	2.23	44.7	0.98	19.5
2006	589	2.77	55.4	2.05	41.1	0.90	17.9
2007	522	2.86	57.2	2.36	46.4	1.03	20.2
2008	472	2.83	56.6	2.35	48.5	1.02	21.1
2009	721	2.77	55.5	2.24	44.7	0.98	19.5
	2766 (total No. of samples)	2.83	56.7	2.25	45.1	0.98	19.7

averages

Manure Generation Estimates

- University of Delaware ..... 1.25 tons per 1000 birds
- University of Maryland ..... 1.0 tons per 1000 birds
- Penn State .... 20 lbs per 1000 lbs of birds
  1.07 tons per 1000 small birds
  1.65 tons per 1000 large birds
- Arkansas .... 1.025 tons per 1000 birds
- NRAES .... 1.25 tons per 1000 birds
- Alabama .... 0.6 lbs per lb of meat produced
  (~ 1.7 tons per 1000 birds)

Case Study: *Sussex County, Delaware*

	EPA/ASAE Approach	units
Bird Inventory	43,620,576	# of birds on any given day (2007 Census)
Animal Unit Definition	455	# of birds per 1000 lbs of animal mass
Total Animal Unit Inventory	95,869	animal units on any given day
Manure Production	85	lbs of manure per animal unit per day
Total Manure Produced	1,487,174	tons wet excretion per year
Nitrogen Concentration	0.0129	lbs TKN per lb of manure
Phosphorous Concentration	0.0035	lbs Total P per lb of manure
Total Nitrogen Produced	38,491,563	lbs Total N per year
Total Nitrogen Not Volatized	35,332,221	lbs Total N per year
Total Phosphorous Produced	10,497,699	lbs Total P per year
Total Phosphorous Produced	8,818,067	lbs Total P per year
with 16% phytase credit		

|	UD/DDA/UMD Approach	units
No of Birds	43,620,576	# of birds
No of Flocks per Year	4.8	flock per year
Total Number of Birds Produced	209,378,765	birds per year
Manure Production	1.25	tons per 1000 birds
Total Manure Produced	261,723	tons per year
Nitrogen Concentration	56.80	lbs Total N per ton
Phosphorous Concentration	19.50	lbs Total P per ton
Total Nitrogen Produced	14,839,720	lbs Total N per year
Total Phosphorous Produced	5,103,607	lbs Total P per year

Implications and Current Status

- Daily Loading of nutrients may be much lower from agriculture and food production systems (significant TMDL implications).

- Chesapeake Bay Program modelers are working with us to better understand modern nutrient generation prediction methods.

- Issue being evaluated by the appropriate agricultural committee within the Chesapeake Bay Program.

Questions?

Comments?

Nitrogen Concentration Trend

Delaware

Slope equal to zero
(Greater than 95% confidence)
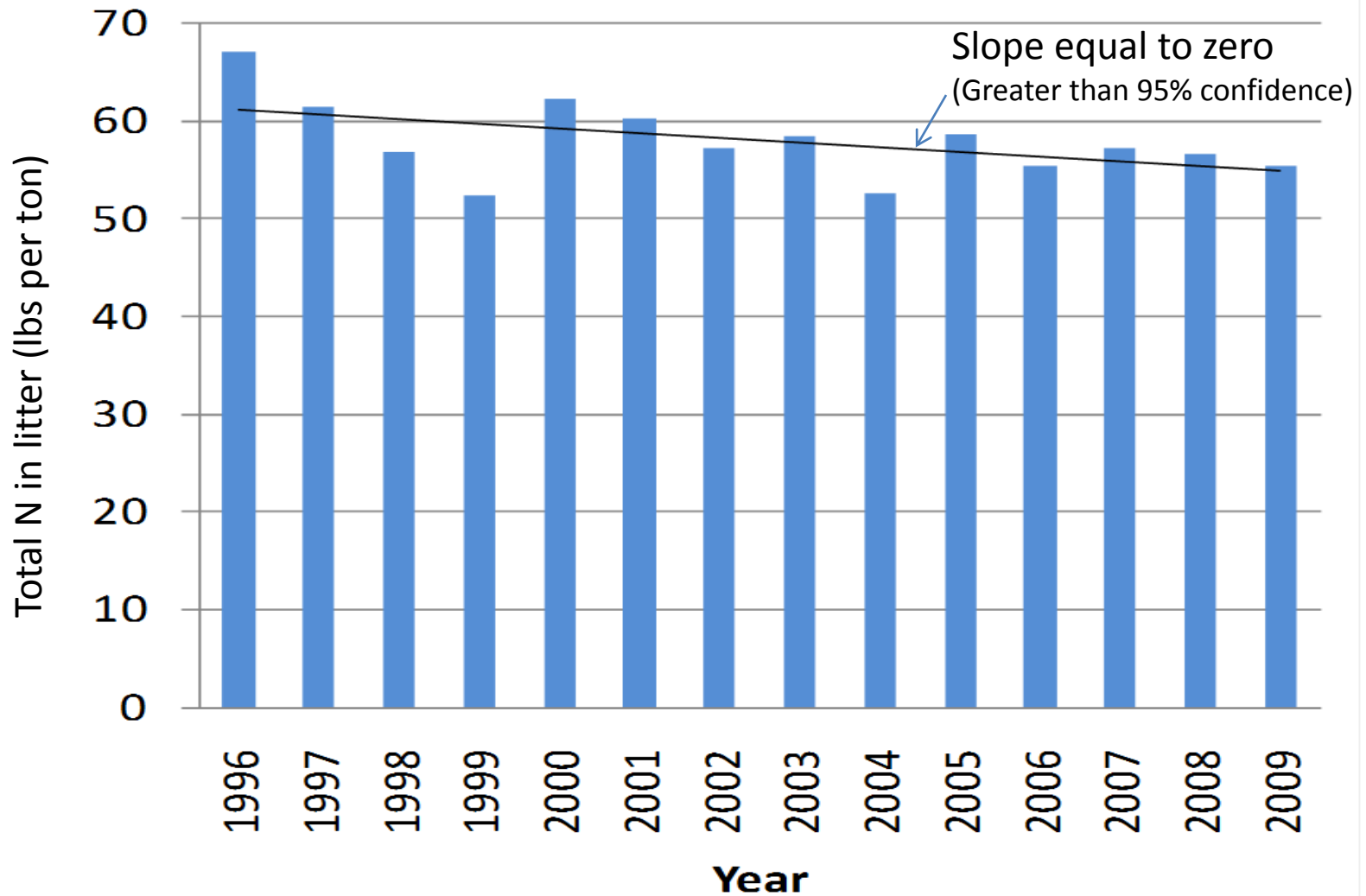
Poultry Production on Delmarva

	Finished Bird Wt (lbs)	Growout (days)	Flock per Year	% on Delmarva
Broilers	5.7	49	5.5	40
Roasters	8	61	4.3	60
Delmarva Average	7.08	56.2	4.8	100

ASAE Standard, 2003 (cont')

*All values wet basis.

†Differences within species according to usage exist, but sufficient fresh manure data to list these differences was not found. Typical live animal masses for which manure values represent are: dairy, 1400 lb; beef, 800 lb; veal, 200 lb; swine, 135 lb; sheep, 60 lb; goat, 140 lb; horse, 1000 lb; layer, 4 lb; broiler, 2 lb; turkey, 15 lb; and duck, 3 lb.

‡Feces and urine as voided.

§Parameter means within each animal species are comprised of varying populations of data. Maximum numbers of data points for each species are: dairy, 85; beef, 50; veal, 5; swine, 58; sheep, 39; goat, 3; horse, 31; layer, 74; broiler, 14; turkey, 18; and duck, 6.

‖All nutrients and metals values are given in elemental form.

#Mean bacteria colonies per 1,000 lb animal mass multiplied by 10^{10}. Colonies per 1,000 lb animal mass divided by lb total manure per 1,000 lb animal mass multiplied by density (lb/ft^3) equals colonies per ft^3 of manure.

**Data not found.