Documentation of Nitrogen and Phosphorus Loadings From Wildlife Populations

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April 2009

Hundreds of species of mammals, birds, amphibians, and reptiles find their home in the Upper Mississippi River Basin. Most are small and may be of local interest, but bear, deer, and elk attract more attention. Rocky Mountain Elk were once plentiful in the Basin, but now number in the low thousands. Their numbers are carefully managed to match the habitat available (USDA, 1999).

Bear are more numerous in the UMRB with numbers estimated at 50,000 in Minnesota and Wisconsin (Julian, 2001 and WDNR, 2008), with small but growing numbers in Missouri from re-introduction efforts (Missouri Conservationist, 2007). Bear habitat is fairly well confined to more remote wooded areas in the Basin. Bears contribute an estimated 550 tons of nitrogen and 220 tons of phosphorus annually to the UMRB through their feces and urine. Since they essentially recycle the nutrients they remove from the landscape, their net impact is minor, and normally considered as part of the 'background' water quality.

Bear numbers in the UMRB are fairly elusive, but several sources give at least a hint. Julian, Chris, More Bears May Lead to More Hunting, Minnesota Public Radio, St. Paul, Minnesota, July 2001 indicates there are upwards of 40,000 bear in Minnesota with a typical range of 15 – 30,000. In Wisconsin, Wisconsin Department of Natural Resources, Wisconsin Black Bear Population and Distribution, Madison, Wisconsin May, 2008 provides an estimated population of 13-20,000. In Missouri bear was essentially exterminated from the state, but introduced bears in the Ozarks now number in the thousands (Missouri Conservationist, Be Bear Wise in Missouri, Missouri Department of Conservation, Columbia, Missouri 2007) roaming the hills of the Ozarks that are outside of the study boundary. All reports are the bear populations are growing fairly rapidly, and both Minnesota and Wisconsin are promoting bear hunts. For the purpose of discussion, use high end numbers of bear 20,000 in Wisconsin and 30,000 in Minnesota.

Bear manure estimated at 0.15#N/da/1000 AU and 0.06/da/1000 AU and an average 400 pound bear. Some are larger, particularly the males, but younger bears are also included in the total. There is little information on bear manure and its characteristics. What few studies have been done looked primarily at brown bear, then more at seed germination than at the manure characteristics. The numbers above are based on a series of assumptions and understandings, the most important is the diet and digestive process for bears and swine are relatively close when both are allowed to forage. The daily N and P values above are from AWMFH for swine on maintenance diets.

Deer, on the other hand, populate the entire UMRB. Based on assumptions taken from Dr. George Johnson's work (Johnson, 2001), there are an estimated 2.9 Million deer in

the Upper Mississippi River Basin and some 1.4 Million deer on and around cultivated cropland. These estimates assume an average weighted population of approximately 15 deer per square mile. The concentration of deer varied from a low of 6 per square mile in Iowa to a high of 30 per square mile in Wisconsin. It is assumed the concentration varies within the states as well, but data is not available to further refine the numbers.

Deer populations were estimated based on work by Dr George Johnson (Johnson, George, Deer Population, On Science, St. Louis Post Dispatch, St Louis, MO, January 2001). Dr. Johnson estimated state deer populations and listed as deer per 1000 population of the state as shown in Table D1. It would have been better to use state estimates of deer populations, but some states have not published that information, although hunting regulations normally cite rules based on deer estimated numbers. More about this later.

State populations were taken from 2000 Census data. The common discussion of deer is by concentration, deer per square mile, and that fits well the UMRB where we know land areas. The land areas were taken from one of many web sites providing land areas for each state. The calculations follow from left to right as shown in Table D1. The final calculation was to weight the concentration which amounted to an average over the five states – approximately 15 per square mile.

As a check, of the process, Table D2 provides a comparison of reported deer populations as compared to calculated populations as shown in Table D1. The reported number are similar which gives some confidence the populations calculated for states with missing data are approximately correct.

Table D1. Calculating concentrations of deer in units of deer per square mile

STATE	***Deer per 1000 population***	***Population of state – Year 2000***	***Deer Population***	***Area of state in square miles***	***Concentration in deer per square mile***
IA	*126*	*2.9 M*	*365400*	*56300*	*6*
IL	*65*	*12.4 M*	*819000*	*57900*	*14*
WI	*346*	*5.6 M*	*1937600*	*65500*	*30*
MO	*175*	*5.6 M*	*989000*	*69700*	*14*
MN	*219*	*4.9 M*	*1073100*	*86900*	*12*

Table D2. Comparison of reported and calculated deer populations for states reporting populations

STATE	***Deer Population as Calculated***	***Deer Population as Reported***
IA	*365400*	*380000*
IL	*819000*	*775000*
WI	*1937600*	-
MO	*989000*	-
MN	*1073100*	*1000000*

Deer on and around cropland in the UMRB excrete 11,600 tons of nitrogen and 2,600 tons of phosphorus annually. Considering expected losses such as volatilization of nitrogen (mainly in the urine), approximately 5,800 tons of nitrogen and 2,600 tons of phosphorus are added to the UMRB annually. While the numbers are large, they represent approximately 0.20 pounds N and 0.09 pounds P per year per acre of cropland. Like bears, deer essentially recycle nutrients they remove from the landscape, and in large part would have minor impacts on over-all water quality of the Upper Mississippi River Basin.

Actual deer manure characteristics are fairly well unavailable. Some sources such as the deer industry chat room suggested pound for pound, deer manure is similar in composition to horse manure, because the animals eat a similar diet when the grass is available. The average weight of deer was assumed at 170 pounds taken from "Average Weights for minor livestock and poultry" I authored, discounting 25 percent due to domestic herds being more robust and healthy than those in the wild. Manure characteristics used for deer was 8.2 tons per year per 1000 pound animal unit, 12 lbs N per ton of manure and 2.7 pounds P per ton of manure.

Quantifying the actual impact of deer on water quality in the UM requires making judgments and assumptions. First, deer prefer to bed down in cover typical of riparian areas and field boundaries. We can assume they spend a larger proportion of their time in these secluded areas as compared to open fields (Johnson, 2001). Consequently, we would assume a larger portion of their feces and urine would be deposited here as well. Second, deer depend on sources of water such as streams and open water for survival. Some feces and urine would be deposited in or adjacent to these water sources. Next we need to assume deer spend 10 percent of their time in or next to water with 90 percent of the nutrients in feces and urine deposited here reaching the water source. We could also assume some 20 percent of the nutrients from feces and urine deposited away from the water source also find their way to water. These are liberal estimates and should be considered extreme cases, but are included here to illustrate the relative impact of different contamination sources on water quality of the Upper Mississippi River Basin.

Based on the numbers above, we could assume the annual loading to water from deer in the UMRB to be approximately 1600 tons of N and 700 tons of P. The CEAP cropland analysis showed cultivated cropland contributes a total of 750,000 tons of nitrogen and 85,000 tons of P to waters of the UMRB in the current conservation condition scenario considering all pathways. Even the liberal estimate of the impact of deer on and around cropland on loadings to waters of the UMRB show the contribution of deer to be less than one percent of the total cropland loading, and in the case of nitrogen, much less. See Table 1.

Table 1. Comparison of nutrient loading to waters of the UMRB from cultivated cropland and deer population

	Current Conservation Condition Scenario	Improved Conservation Condition Scenario
Total N loading from cropland	750,000 Tons	460,000 Tons
Total N loading from deer**	1600 Tons	1600 Tons
N loading from deer as a percent of cropland load	0.2 Percent	0.35 Percent
Total P loading from cropland	85,000 Tons	41,000 Tons
Total P loading from deer**	700 Tons	700 Tons
P loading from deer as a percent of cropland load	0.8 Percent	1.7 Percent

** These loadings are liberal estimates

In the cultivated cropland Improved Conservation Condition scenario, the CEAP cropland analysis estimates edge of field nutrient loadings at approximately 460,000 tons of N and 41,000 tons of P. Deer populations have shown an increasing trend in the past 50 years across the nation (Johnson, 2001) and there is no reason to assume populations will decrease significantly in future years. If past trends continue, deer populations may increase, particularly considering this scenario would improve deer habitat with filter strips and field borders. . Assuming a stable deer population and the liberal assumptions above, the impact of nutrient loading from deer as compared to cultivated cropland increases somewhat as shown in Table 1, particularly for P, but still remains a minor contributor.

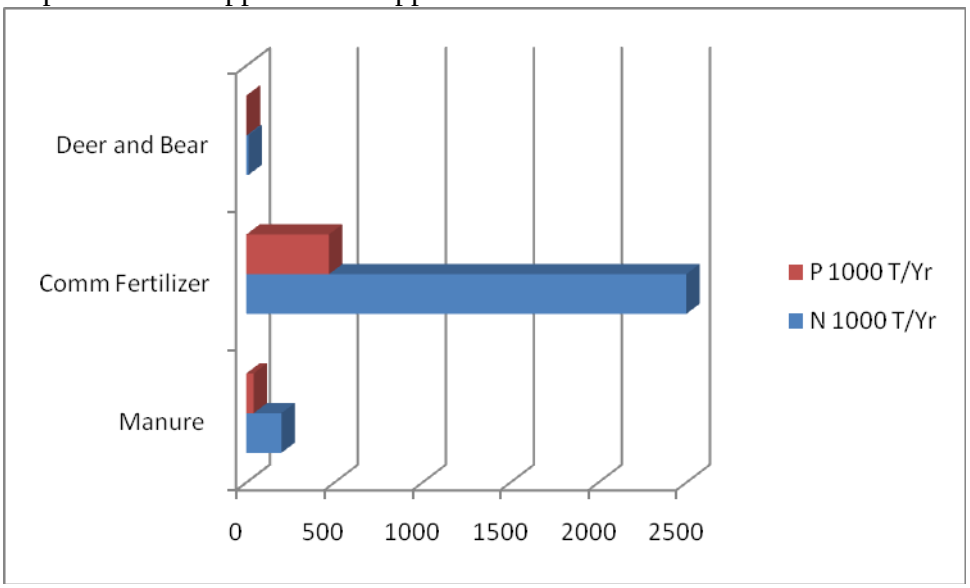
Another way to put the potential water contamination from deer in the UMRB into perspective is to compare it to contributions of livestock and poultry produced in the Basin. USDA has published county-level estimates of manure nutrients produced in the United States (Kellogg et al, 2000), but in the CEAP analysis, estimates were made of the actual manure nutrients applied to cropland and/or excreted by grazing animals on the cropland; all based on survey data. This methodology is compatible with the remainder of the CEAP analysis. Manure nutrients applied to cropland averaged approximately 200,000 tons of N and 42,000 tons of P per year. Commercial nitrogen and phosphorus applications were considerably larger according to the survey estimates. These were approximately 2,500,000 tons of N and 470,000 tons of P per year. Table 2 and Figure 1 displays the relative contribution of manure and commercial sources of N and P with those of bear and deer combined.

Table 2. Contribution of different nutrient sources applied or dropped in and around cropland in the Upper Mississippi River Basin

Nutrient Source	**Nitrogen Tons/Year**	**Phosphorus Tons/Year**
Livestock and Poultry	200,000	42,000
Commercial Sources	2,500,000	470,000

Deer and Bear	12,150	2,820

Figure 1. Contribution of different nutrient sources applied or dropped in and around cropland in the Upper Mississippi River Basin



In addition to larger animals, the Upper Mississippi River Basin is home to large populations of breeding waterfowl (MDNR, 2008 and WDNR,2008) as well as situated in the Mississippi River Flyway used twice each year by millions of migrating waterfowl (Havera et al, 2000 and USF&WS, 2008). Minnesota and Wisconsin are the only states recording waterfowl breeding numbers, but most all states have significant breeding populations (Havera, 2000). For the purposes of this discussion, the breeding waterfowl populations reported for Minnesota and Wisconsin will represent the populations in the Basin as a whole. Table 3 shows the populations reported by the states and an estimate of annual nitrogen and phosphorus production.

Breeding pairs spend approximately six months in the UMRB and approximately 50 percent of that time is spent in or next to water. In that time we could expect approximately 210 tons of nitrogen and 75 tons of phosphorus to be deposited directly in the water. As with deer, the numbers are small in comparison to the edge-of-field loadings from cultivated cropland, but could be significant for a local consideration.

Table 3. Long-term average duck and geese populations for the Upper Mississippi River Basin*, and an estimate of annual nitrogen and phosphorus in excretions.

State	No. of Ducks**	No. of Geese**	Annual N As Excreted	Annual P as Excreted
Minnesota	223,000	161,000	380 Tons	130 Tons
Wisconsin	525,000	90,000	470 Tons	165 Tons
UMRB Total	748,000	251,000	850 Tons	295 Tons

* States of Minnesota and Wisconsin report breeding waterfowl populations, but not all land area of the two states are in the UMRB. Using the whole population from these states is intended to represent the waterfowl populations in states not reporting breeding numbers.
** Breeding adults

Waterfowl population numbers are fairly well documented in the report. We have good data on the domesticated duck/goose manure, but little on the wild waterfowl manure. Conservatively, we could assume the characteristics are similar, which would tend to over estimate the impact of water fowl. Using values from NRCS's AWMFH Chapter 4 for duck of 1 pound N/day/1000 lb animal unit and 0.35 pound P/day/1000 lb AU, and an average weight of duck of 3.5 pounds and goose of 8 pounds, the tons of N and P were calculated. For migrating waterfowl manure estimated, an average weight of 6 pounds per bird was used

Migratory waterfowl numbers in the UMRB are not precisely known, but it would be safe to assume since the Basin occupies the center of the Mississippi River Flyway, at least half of the birds using the Flyway fly through the River Basin. Havera (Havera et al, 2000) estimates during the period of the CEAP study the migratory bird population was over 1,000,000 in the Illinois Valley alone. Using USF&W census data (USF&W, 2008) of over 5,000,000 ducks and geese using the Mississippi River Flyway, we could assume 2.5 Million spend some time in the UMRB twice each year. Lengths of stays within the Basin are not known and do vary year by year depending on many factors including weather conditions along the Flyway. Havera assumes a minimum of one day stay both spring and fall. For each day the birds spend in the UMRB they would excrete 7.5 tons of nitrogen and 2.5 tons of phosphorus. As with other wildlife, these numbers are relatively small in comparison to the impacts of cultivated cropland.

Havera, Stephen P., Michelle Horath, *Waterfowl Populations in the Illinois Valley*, Center For Wildlife Ecology, Illinois Natural History Survey, Urbana, Illinois 2000

Johnson, George, *Deer Population*, On Science, St. Louis Post Dispatch, St Louis, MO, January 2001

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Minnesota Department of Natural Resources, *2008 Waterfowl Breeding Population Survey – Minnesota*, Minneapolis, Minnesota 2008

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Kellogg, Robert L, C.H. Lander, D.C. Moffitt, and N. Gollehon, *Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients – Spatial and Temporal Trends for the United States,* Publication No. nps00-0579, United States Department of Agriculture, Washington, DC 2001

United States Department of Agriculture - Natural Resources Conservation Service, *American Elk,* Fish and Wildlife Management Leaflet Number 11, November, 1999

United States Fish and Wildlife Service, *Waterfowl Population Status – 2008*, Division of Migratory Bird Management. Washington, DC April 2008

Wisconsin Department of Natural Resources, *The Wisconsin Waterfowl Strategic Plan,* Madison, Wisconsin May, 2008

Wisconsin Department of Natural Resources, *Wisconsin Black Bear Population and Distribution,* Madison, Wisconsin May, 2008

Note: The EXCEL spreadsheet "Wildlife Populations" contains the calculations and original for Figure 1.