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TO: U.S. EPA Science Advisory Board Integrated Nitrogen Committee

SUBJECT: Comments on the First External Review Draft of the U.S. EPA SAB Integrated Nitrogen Committee report on reactive nitrogen in the environment

FROM: Clifford S. Snyder, PhD, CCA -

Nitrogen Program Director

The International Plant Nutrition Institute (IPNI) is pleased to offer the following 20 pages of comments and suggestions to help improve and strengthen the science assessment, interpretations, findings, and recommendations in the U.S. EPA Science Advisory Board Integrated Nitrogen Committee's report on reactive nitrogen in the environment.

IPNI is a not-for-profit, science-based organization with a focus on agronomic education and research support. IPNI has established programs in the United States, Canada, China, India, Southeast Asia, Northern Latin America, Brazil, Latin America-Southern Cone, and a new presence in Eastern Europe and Central Asia and soon to be in Australia.

The mission of IPNI is to develop and promote scientific information about the responsible management of plant nutrition for the benefit of the human family. IPNI recognizes the widespread concern for issues such as climate change and water quality protection, and the relationship of crop production to the environment and ecosystem health.

Comments by the International Plant Nutrition Institute

on the

FIRST EXTERNAL REVIEW DRAFT PREPARED BY THE U.S. EPA SCIENCE ADVISORY BOARD'S INTEGRATED NITROGEN COMMITTEE

The U.S. EPA Science Advisory Board Integrated Nitrogen Committee (EPA SAB INC) draft report is an excellent effort to truly integrate the knowledge, findings, and recommendations on reactive nitrogen (Nr) in the environment. The following paragraphs are submitted for the EPA SAB INC's consideration in developing corrections and improvements for the 2nd draft of the report.

General Comments

The USA Nr budget and Nr fluxes are presented throughout the document in many tables and figures, in different ways. The INC is encouraged to develop consistency in reference and presentation among the different chapters and sections. At present, considerable discrepancy in the magnitude of different N pools and fluxes of Nr are found throughout the report. These discrepancies are noted in the specific comments that follow.

To provide clarity in communication definitions of important abbreviations for Nr forms and species, which are included in lines 20 through 31 on page C3-112 of the report, should be included as part of the text in the Executive Summary and also in the general introduction of the report.

Numerous opportunities for correction of grammatical and punctuation errors will not be addressed here in our comments, since we recognize these mistakes will most likely be readily recognized and remedied in the 2nd draft of the INC report.

Accurate accounting of Nr from forest soils

The contributions of Nr from forests may not be accurately accounted for in the INC report. For example, approximately 1.5 million acres of southern pines were fertilized with N in 2002 (Fox et al., 2006) at an average rate of about 175 lb of N/A. Thus, about 131,000 short tons (~ 0.1 Tg of N) of N are input annually in southern pine forests, which is in agreement with the synthetic N input in Table 3-13. Yet, there is some question about the proper accounting of the **release of Nr in harvested forests.** Research with southern pines by the Forest Nutrition Cooperative (North Carolina State University, Virginia Polytechnic Institute and State University, Universidad de Concepcion; http://www.forestnutrition.org/) for example, has shown there is a large release of Nr from the soil pool within the first few years after a southern pine tree harvest (Fox et al, 2006 and http://www.forestnutrition.org/limitations.htm). This increased soil N mineralization and nitrification with tree harvesting (see Figure 1 below) was also reported by Vitousek and Matson (1985).

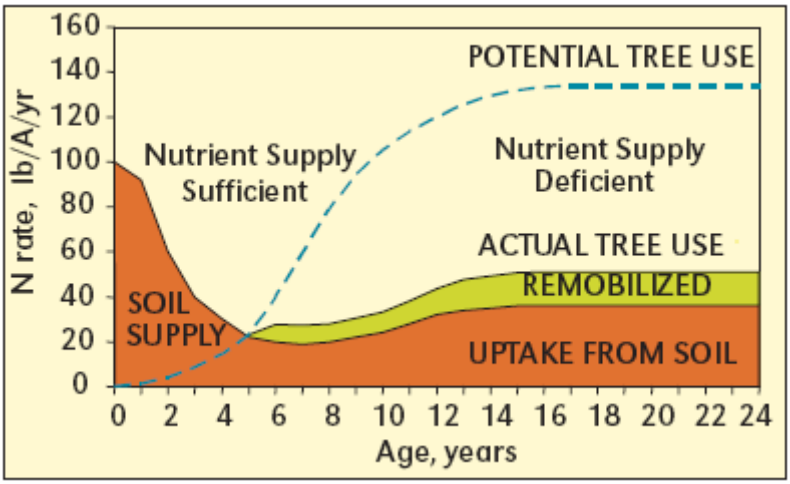

Figure 1 – Conceptual relationship of a southern pine stand's soil nitrogen supply and the potential and actual use of nitrogen versus tree age or tree harvest (Fox et al., 2006).

The total U.S. forest land in 2002 was estimated at 749 million acres (Smith et al. 2004), of which there were 32 million acres of southern pines in the southeastern states (Fox et al., 2006). Two-thirds (513 million acres) of the U.S. forest land was considered timberland (*forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation*). Seventy-one percent of the timberland is privately owned, but accounts for 92 percent of the growing stock removal (i.e. tree harvest). Trees were harvested on 10.8 million acres/yr, on average for 2001-2005; representing about 2.1% of the total timberlands (Smith et al., 2004). By comparison, there were 442 million acres of crop land in the U.S. in 2002, and 340 million acres of that total were used to produce crops (Lubowski et al., 2006).

Depending on the intensity of tree harvest, site-preparation, and competition control measures, as much as 70 to 100 lb of Nr/A/yr may be released from southern soils within the first year or two after tree harvest. So, on all U.S. timberlands, **as much as 367, 000 short tons (0.3 Tg) of Nr may be released annually through forest harvests in the U.S.** (*based on the low end of the range of Nr released in harvested southern pine stands* (see Figure 1 above; Fox et al, 2006)). This harvest-induced release of Nr from the soil and litter layers is three times the amount of synthetic N input to forest and grassland systems shown in Table 3-13 of the INC report. This harvest-induced Nr release from harvested forests should be considered in the EPA SAB INC report.

Specific comments/suggestions

Page and line

C1-1, line 7 – change "artificial" to "synthetic" to more truthfully and fairly represent the commercial production and synthesis of fertilizer N. Use of "artificial" may imply to the public that there is something not real about fertilizer N, which could result in inferences that the fertilizer industry is producing something "artificial" N, …. which could lead to misperceptions about honesty and disclosure. The fertilizer industry merely captures N_2 from the atmosphere in the synthetic production of fertilizer, to enable wise nourishment of plants for the benefit of the human family.

C1-1, line 15 – add the words "the soil and" just before "environmental reservoirs". Insert "(soil, water, air)" just after "environmental reservoirs".

C1-2, lines 11-14 – show "Tg N/year" instead of "Tg N" throughout paragraph

C1-6, lines 36 and 37 – add U.S. Army Corps of Engineers to the list of federal agencies

C1-7, lines 15 through 16 – the abbreviations CAIR and EGU should be spelled out for clarity

line 18 – NOy and NHx should be defined

line 20 – the INC report authors may wish to include mention of the need for both public and private sector education, outreach, and communication.

line 27 – is the EPA INC recommending that the referenced Task Forces review the legislation and regulatory authority of EPA over nonpoint source N pollution, to enact Nr risk reduction?

line 31 – change "Recommendations" to "recommendations"

line 34 – What is the basis for selecting the year 1990 as a reference point?

line 35 – PM should be defined

C1-8, lines 2 through 5 – Recommendation R1-3 – How does the INC suggest this reduction be accomplished: through implementation of fertilizer N BMPs (source, rate, timing placement), or by other means? Recommendations R1-1 and R1-2 mention ways the reductions should be accomplished.

lines 6 through 8 – what is meant by "targeted construction" for nutrient management? Which nutrient management practices will this assist with?

lines 9 through 14 –There is a strong need to consider the importance of adequate N to sustain soil C and N balances, to allow for enhanced soil C sequestration and the maintenance and improvement of long-term soil productivity for agricultural cropping systems. In the agro-ecological context, soil productivity maintenance and improvement for agricultural cropping ecosystems in the rural landscape should be a high-priority consideration in the EPA INC report.

Figure 1-1 – abbreviations should be spelled out or identified in the text.

C1-9 - Figure 1-2 - abbreviations should be spelled out or identified in the text.

C2-1, line 33 – Although citation of Erisman (2008) is germane, it is recommended that the report also cite Vaclav Smil's book: Smil, V. 2001. Enriching the Earth –Fritz Haber, Carl Bosch, and the Transformation of World Food Production. Massachusetts Institute of Technology Press. 338 pp.

C2-2, line 9 – **It is not clear if U.S. exports of protein-containing food products (and N) are fully considered in the Nr input and output budget shown in Figure 1-2.**

Many countries also export large quantities of meat and other protein-containing food products. The export of these foods and food products should also be mentioned. For example, based on information reported by the U.S. Meat Export Federation (http://www.usmef.org/TradeLibrary/Statistics.asp), the U.S. exported 1.2 million metric tons (MMT) of beef, 726,00 metric tons of pork in 2002. In 2007, the U.S. exported 650,000 metric tons of beef and veal, 1.4 million metric tons (MMT) of pork, and 2.9 MMT of broilers and turkeys (http://www.fas.usda.gov/psdonline/circulars/livestock_poultry.pdf). In 2004, the U.S. exported 56.4 million dozen table eggs (http://www.aeb.org/Assets/PDF/IndustryFacts/EggFactSheet.pdf) and increased exports to 78.7 million dozen in 2007 (http://www.unitedegg.org/useggindustry_generalstats.aspx).
In 2007, the U.S. exported 6.65 MMT of dairy products (http://www.fas.usda.gov/psdonline/psdResult.aspx). The N contents of beef, pork, poultry (chicken broiler and turkey), assuming 6.25 x protein = N content, and the N content of whole milk, assuming milk protein =6.38 x N content, are roughly: 5.2, 5.2, 5.0, and 5.0 %, respectively (http://www.nal.usda.gov/fnic/foodcomp/Data/SR17/wtrank/sr17w203.pdf).

C2-2, lines 40 through 42 and C3—3, lines 1 through 7 -

Categorizing “environmental changes” and “human and ecosystem consequences” as separate components of the N cascade appears somewhat duplicative, since “environmental changes” and “ecosystem consequences” may be considered equivalent terms. The INC should change “human and ecosystem consequences” to “human consequences” in line 42 on page C2-2, and modify the text accordingly in lines 1 through 7 on page C3-3.

C2-4, Figure 2-1 – no mention of new N for fiber production is made. The box in Figure 2-1 that shows “food” should be changed to reflect “food and fiber”.

Consider that cotton is produced on about 10 million acres each year, According to the USDA Economic Research Service (http://www.ers.usda.gov/Briefing/Cotton/), “Cotton is the single most important textile fiber in the world, accounting for nearly 40 percent of total world fiber production. While some 80 countries from around the globe produce cotton, the United States, China, and India together provide over half the world's cotton. The United States, while typically ranking second to China in production, is the leading exporter, accounting for over one-third of global trade in raw cotton.”

The rate of N applied to cotton rose from the 1980s into 2000 (Snyder et al, 2005), and is currently about 90 lb N/A (USDA NASS 2006) and equates to a total of approximately 0.4 Tg N input annually.

Figure 2-1 and line 26 – define NOx

C2-5, lines 1 and 2 – define NOy and N org

line 19 – add “and runoff” after “leaching”

C2-7, line 33 - add “and runoff” after “leaching”

C3-2, Table 3-1 – Manure N is considered a contributor to atmospheric and terrestrial compartments, and it may be considered an input to the aquatic compartment. Since manure N originates from feeds and from forages produced with N derived from the soil and/or fertilizer and/or cultivated biological N fixation, manure N as inputs in these three compartments might be viewed as duplicative accounting; since soil, fertilizer and cultivated biological N fixation are already accounted for. If the EPA INC wishes to identify manure N among the three compartments in Table 3-1, then manure N should be shown as a subset of soil, fertilizer, and cultivated biological N fixation.

Making this change in the Nr flux would account for 7.63 Tg (36%) of the “missing”N (21 Tg) illustrated in Figure 1-2.

A comparison of Table 3-1 with Figure 1.2 raises a serious concern about inconsistency or errors (perhaps related to large uncertainties) in the budgets shown in the EPA INC report. Figure 1.2 shows total U.S. N inputs at 35 Tg of N, while Table 3-1 shows inputs to the three compartments as 58.3 Tg N/yr (atmospheric= 10.0 , terrestrial = 43.5, aquatic = 4.8 Tg). These discrepancies warrant more explanation and possible correction.

C3-3, line 10 – add "states" after "U.S."
line 12 – define CMAQ
lines 20-35 – the specific years of several of these government reports should be cited for clarity, and a complete reference should be included in the references list.

C3-6, line 17 – please define SCR
Line 28 – add "state" after "individual"

C3-7, line 27 – please define EGU

C3-8, lines 5 through 8 – the emphasis on reductions in Nr associated with off-highway sources is understandable. Further reductions of Nr from other mobile and stationary sources should also be encouraged.

C3-9, line 4 – Terry (2006) should be added as a reference to support the statements

lines 21 through 24 – Terry (2006) may be cited to support these assertions

C3-10, lines 21 through 35 - The USDA National Agricultural Statistics Service and/or Economic Research Service agricultural chemical use surveys are informative and do help contribute information that can be used in educational efforts to improve nutrient management. Survey data on agricultural chemical use (and fertilizer N use) by corn were not collected in 2002, 2003, and 2004; nor were they collected in 2006 and 2007. These are very important years because of the shifts in corn use for biofuels production. These data gaps were pointed out in EPA's Hypoxia Science Advisory Board report (EPA Hypoxia SAB, 2007), but should also be raised by the EPA INC as a point of recommendation to EPA to assist in encouraging the USDA to resume the <u>annual</u> collection of data on ag chemical use by corn in the U.S. Potential environmental impacts of increased N inputs associated with expanded corn acreage for biofuel production cannot be properly evaluated in the absence of such critical nutrient management data.

C3-13, lines 15 through 17 – Finding F3-3 is not accurate, since implementation of fertilizer BMPs (not just changes in N rate applied) cannot be ascertained from USDA statistics.

The USDA survey results are averaged over survey participants and it is not possible to make specific conclusions about BMP adoption or implementation.

Most state Land Grant universities provide nutrient recommendations to farmers. The fertilizer industry and Certified Crop Advisors also advise farmers on nutrient management. Clearly, there is a large opportunity for expanded education and outreach - by the private sector and the public sector - on N BMPs for environmental protection, in addition to education on agricultural crop yield and quality response to N.

lines 19 through 21 – Recommendation R3-3 seems plausible but more detail is likely warranted.

Please define NRD. Is the NRD system in Nebraska effectively enforcing a maximum N use rate?

Although enhanced efficiency fertilizers have the potential to increase crop recovery of applied N in specific crop and soil/site situations, more research is needed to document/prove environmental benefits of these technologies; especially at small and large watershed scales.

Nutrient management plans are beneficial if properly prepared AND implemented. However, they must be flexible because of changing economics, cropping system adjustments, and unpredictable weather. **One of the most important features of a good nutrient management plan is a partial nutrient balance to determine if nutrients are being applied considerably above crop removal**.

Education and outreach to encourage adoption of newer technologies should not be restricted to university extension alone; the private sector can also play an important role in technology transfer. The INC may wish to consider including statements to encourage EPA and state nonpoint source environmental authorities to work collaboratively with the nonprofit, private sector in such education and outreach efforts.

C3-16, lines 1 through 7, Recommendation R3-4 – While NUE, as defined earlier in the report, can be used as an indicator of crop productivity per unit of N applied, it may or may not provide indication of the risk or magnitude of environmental N loss. For example, a high NUE may be achieved on a given site which has a long history of over-application of manure N. Such a history might lead to a high soil residual N level, and when properly considered, enable use of a lowered fertilizer N rate. Consequently, calculation of the fertilizer NUE following years of excessive manure N use would appear quite positive. However, there may still be considerable risk of environmental N loss if the soil characteristics are conducive to loss of the residual N. Consideration of nutrient balance in nutrient management plans, to include all significant N inputs, may also be needed to in further assessment of the risk for environmental N loss (Snyder, 2008).

lines 9-11, Recommendation R3-4 – It is not correct to refer to “smart” fertilizers, especially as controlled release alone. It would be more appropriate to term these fertilizers as “enhanced efficiency fertilizers". Controlled release N fertilizers are only one example of such enhanced efficiency fertilizers. Urease inhibitors, nitrification inhibitors, ……as well as proper fertilizer source, rate, timing, and placement can also provide potential agronomic and environmental protection benefits (Snyder, 2008). Further, there is limited research to date to document the environmental benefits of such enhanced efficiency fertilizers. More research is needed with “enhanced efficiency fertilizers” and various fertilizer BMPs in different cropping systems, to determine and demonstrate their benefits in protecting air and water quality.

C3-17, line 3 - Salvagiotti et al., 2008 is not found in the references listed at the end of this section of the report.

line 15 - a reference should be included to support this statement on denitrification.

line 27-32 – a review by Snyder et al. (2007) also showed wide ranges in N_2O emissions among fertilizer N sources and N rates in the literature, but the median fertilizer induced emission among N sources was 0.26 to 1.56 kg N/ha. Parkin and Kaspar (2006) reported losses in Iowa from 2.2 to 2.7 kg N_2O-N/ha/yr on soils planted to soybean, and 7.6 to 10.2 kg N_2O-N/ha/yr on soils planted to corn. The higher emissions with corn were associated with peak N_2O flux events within several weeks after fertilizer N (202 kg N/ha) application. Emissions of N_2O in the Iowa study were higher than would have been predicted using the IPCC 1% factor, which underscores the need for site-specific nutrient management.

C3-19, lines 4-14, and Finding F3-5 and Recommendation R3-5 – we strongly agree with these statements and would encourage more research in the U.S. Cornbelt states, especially in the humid, higher rainfall and warmer states east of the Mississippi River.

lines 34 through 35 - corn prices have risen since 2005, but statements in the text need to be changed to also reflect the corn price declines in 2008. Failure to frame the price variability correctly can result in misleading communication and mistaken conclusions, which could result in misguided policy decisions.

C3-20, lines 8 through 16, and Finding F3-6 and recommendation R3-6 – similar to the above comment, text preceding the Finding F3-6 statements needs to be changed because of the dynamic nature of corn prices and fertilizer N prices. Although the increased cost of production associated with fertilizer price increases influences farmer management decisions, the price ratio for corn and fertilizer N may be the dominant factor

influencing corn production and use as a biofuel. Perhaps it would be best to just point to the fluctuating price ratios, instead of the absolute prices?

lines 12 through 16 – the text needs changed to reflect a complete sentence. Is there a specific recommendation to EPA or USDA in how the two agencies should work together in addressing this challenge?

C3-21, line 5 – insert "management and" before "labor"

lines 44 and 45– change "ammonia" to "ammonia/ammonium"

C3-22, line 1 - change "ammonia" to "ammonia/ammonium"
line 13- "40 kg milk per annum" is an error. Many dairy cows produce 180 lb/day, or 81.7 kg milk/day. Many cows produce above 19,000 lb of milk/year, or 8,626 kg milk/annum. This is reinforced by the data shown in Figure 3-7 on page C3-26.

lines 32 through 34, Recommendation R3-7 – if the recommendation is to monitor ammonia/ammonium emissions/deposition via a national network of monitoring stations, then that should be clearly stated. If the recommendation is to monitor all the gaseous emissions stated in F3-7, that should be more clearly stated.

C3-28, lines 27 and 28 – it would be more accurate to state "recovered and applied directly as fertilizer for crop production", as opposed to stating "used as fertilizer for crop production". Many livestock producers consider the nutrients which are recycled to the grazed forage/land surface in feces and urine deposits as "fertilizer for crop production".

line 32 – insert "also" before "susceptible"

C3-29, line 16 – the 2002 value of 6.8 Tg for manure N In Table 3-8 is in disagreement with the atmospheric (0.03 + 1.6 Tg) and terrestrial inputs (6.0) for manure shown in Table 3-1, which total 7.63 Tg. **These disagreements between Tables 3-1, 3-7, and 3-8 need to be resolved and a single table should be identified as the guiding budget from which all findings and recommendations in the document by the EPA INC are based**. **These differences/discrepancies might also be explained as the uncertainties in the various Nr input estimates.**

lines 30-32, Recommendation R3-8 – A complete sentence is needed, perhaps to suggest that EPA and USDA should work together to develop a policy that includes an incentive framework. Is the EPA INC suggesting regulatory follow-up/enforcement for CAFOs, different from existing policy/regulation?

C3-30, lines 23 through 31 – these statements regarding the fate of N applied to turf should be supported by references

C3-31, lines 16-19 – the sentence, "*Further nitrogen reductions can be made if white clover is incorporated into turf and grasses such as fescues are selected for amenable parts of the country, which require little or no nitrogen supplements once mature*", should be supported by a reference. Inclusion of white clover (or other legumes) in cool season turf situations usually precludes the use of broadleaf herbicides which may be necessary to control invasive or noxious broadleaf plants.

C3-38, lines 7 and 8 – it is not clear in Table 3-10 and Figure 3-9 that reduced N is ammonium and that oxidized N is nitrate. This should be clearly indicated in the table and figure, and it should be stated in the text.

C3-44 –the legend for Figure 3-12 is spread to the left and to the right of the figure and should be corrected.

C3-46, line 44 – insert "River" after "Mississippi" to avoid reader confusion

C3-47, lines 20 through 23, Finding F3-9 – a statement should be added here to indicate that wet deposition of N has declined, when comparing the averages of 1994-2000 (3.26 kg N/ha/yr) with averages for 2001-2006 (3.14 kg N/ha/yr), based on data in Table 3-10, and supported by Figures 3-9 and 3-10.

line 25, Finding F3-10 – it is highly speculative, and possibly scientifically incorrect, to say that emissions of ammonia from agricultural sources have been increasing if there are no data to support such a claim. Although Figure 3-9 shows increases in reduced N deposition, and the text asserts the opinion that wet deposition of reduced N is likely due to increased ammonia emissions (and other reduced N compounds). The text on page C3-42, lines 38 and 29, states: "*Ammonia emissions and ambient concentrations can be measured, but are not routinely monitored*." Accordingly, this finding (F3-10) should be revised to accurately reflect the current facts, and not speculation.

lines 28-29, under Finding F3-10 – the levels of "ammonia, ammonium, and possibly organic nitrogen" are not routinely monitored. Neither are their values reported in the previous sections, nor is there evidence reported to associate specific concentrations of these N compounds with human health and welfare risks. Therefore, we strongly advise changing this finding (F3-10) to state what is known, or to state that potential health risks associated with emissions are suspected.

lines 39 and 40, Recommendation R3-11 – there is no specific mention of atmospheric NO_2 concentrations in the previous section, nor specific mention of an existing standard

that is associated with human health. The statements should be deleted or modified to clearly make a recommendation as a complete sentence. Also, text in the previous sections should be substantially improved to clearly communicate any established scientific link between NO_2 and ozone or other human health risks, before stating any recommendation. This association may be documented in the scientific literature, but it is not common knowledge.

lines 45 and 46, Recommendation R3-13 - the recommendation should be a complete sentence.

C3-48, line 20 – change "fertilizer" to "required N" to prevent direct confusion with synthetic fertilizer N.

line 23 – Table 3-1 shows 29.4 Tg of new Nr. This discrepancy with the stated 32 Tg of new Nr needs to be corrected.

C3-49, line 36 – the value shown for the Tg of N represented in U.S. milk production (0.5 Tg of N) appears low. If the protein content of whole milk is 32.2% (http://www.nal.usda.gov/fnic/foodcomp/Data/SR17/wtrank/sr17w203.pdf), and milk protein =6.38 x N%, then the N in the milk produced in the U.S. in 2002 was : (77 Tg of milk x 0.322)/6.38 = 3.9 Tg of N.

Line 39 – a reference is needed to support the statement that 21% of the anthropically introduced N in forests and grasslands was retained in soil or tree biomass.

> Baker et al. (1974) reported, " *Pinus* ecosystems apparently exhibit relatively low recoveries of applied N". "Nitrogen recovery in such ecosystems ranges from 3 to 24% and averages 14%." They were referring to recovery of applied N in above-ground vegetation, including the trees. However, immobilization of N by soil microbes may account for large fractions of the Nr in intensively managed forests (Vitousek and Matson, 1985). More research is needed to evaluate fertilizer N use efficiency in intensively managed forests, since few or no relevant papers have been published since the 1974 report by Baker et al. , to determine recovery of applied N in both above- and below-ground ecosystem compartments (*personal communication with Dr. Tom Fox, VPI & S.U. and the Forest Nutrition Cooperative - December 5, 2008*)

C3-51 - lines 4 through 14 – **references should be provided to support the basis for these estimates in the text, and which are shown in Figure 3-13**.

What are the assumptions regarding N storage in soils, how is 0.74 Tg N storage in soils and vegetation arrived at for forests and grasslands? How were the 0.8 and 0.12 values determined for soil and vegetation storage in "Agricultural" and "Populated" systems in

Figure 3-13? These storage values imply increases in soil organic matter levels. While we do not question that soil organic matter is being increased above the levels observed in prior decades, through improved cropping system management and reduced tillage practices, ….. it is important to provide supporting references for these estimates. Also, how was the estimate of 7.6 Tg of N loss from "Agricultural" systems determined? **This should also be supported by a reference(s).**

There is a large discrepancy between the terrestrial inputs of N in the U.S. shown as 43.5 Tg N in Table 3.1, and the total N input (30.8 Tg N) to the "Vegetated" (9.9 Tg N), "Agricultural" (19.6 Tg N), and the "Populated" (1.3 Tg N) systems.

Also, inputs into Agricultural systems (19.6 Tg N) do not balance with the sum of products, transfers, and N loss (2.08 Tg N). What is the reason for this discrepancy? AN explanation is needed to account for the removal of N from the "Agricultural" system in excess of N inputs? Is the estimate of N Loss (7.6 Tg N) too high?

C3-53, line 7 - what is the time frame referred to? Please offer a bracket of years.

line 10 – although to many, increased N discharge to coastal waters may be a foregone conclusion, it may be helpful and constructive to mention that N discharge to coastal waters can be reduced. For example, there was a 21% <u>reduction</u> in total N discharge to the Gulf of Mexico for the 2001 to 2005 period compared with the 1980-1996 period (EPA Hypoxia SAB, 2007). It seems important to note such a significant decrease in N discharge to a coastal ecosystem; especially since these data were not well-exposed in EPA's Hypoxia SAB publication, the EPA Hypoxia SAB report is highlighted on page C3-55 of this report, and because federal and state agencies have developed a new five-year Action Plan based on the science, findings, and recommendations in the Hypoxia SAB report. **It is important to convey a positive message to the public: Management actions can result in reduced environmental N loss and ecosystem benefits.**

C3-55, lines 12 and 13 – it would be more correct to state - "originate in the upper Mississippi, Missouri, Ohio, Tennessee, Arkansas-Red-White, and lower Mississippi river watersheds".

C3-56, lines 39 and 40 – Please compare this 17% of N input from synthetic fertilizer (equates to 1.6 Tg N) stored in cropland mineral soils annually, with the "N storage" value in the Agricultural component of Terrestrial systems (0.8 Tg N). Figure 3-13 should be in agreement with the text in this section of the report, and with Table 3-15. It is important that this two-fold discrepancy be addressed.

C3-58, lines 15 through 18 – the assumption that forests are 85% softwood and 15% hardwood appears incorrect, based on the latest USDA Forest Service resource inventory (Smith et al., 2004). Table 17 in the USDA Forest Service report indicates that of the 932, 566

million cubic feet (MCF) of all timber in the U.S., 520,238 MCF (55.8%) is softwood and 412,332 MCF (44.2%) is hardwood. This difference may affect the estimates in Table 3-16.

C3-59, line 30 – Table 3-1 showed terrestrial inputs from atmospheric deposition, biological N fixation and synthetic fertilizer as, 6.9 + 14.1+ 15.1=36.1 Tg N: not the 25 Tg N shown. Is 36.1 the value for all of the U.S., or for the lower 48 states? Please correct and clarify reasons for these discrepancies.

C3-60, lines 4 through 6 – This sentence, "There are no comprehensive data available to assess the transfer and transformations in and between the atmosphere, terrestrial systems (agriculture, populated and vegetated systems) and aquatic systems nationally.", should be placed as a footnote under Figure 3-13 on C3-51.

line 23 – insert "(34.2 kg/ha/yr)" at the end of the sentence, for reader clarity.

C3-61, line 3, Figure 3-14 – change "all 16 watersheds" to "all 16 catchments"
line 4 – insert "(34.2 kg/ha/yr)" before the reference, for reader clarity
line 22 – Van Breemen and not Van Breeman

C3-62, lines 1 through 9 - while it is understandable to attempt budgets and flows of N for the entire U.S., it is important to recognize that in the example for the northeast U.S., 72% of the area was forested and 19% was agricultural. In contrast, 29% of the U.S. was forested and 45% was agricultural (19.5% crops + 25.9% pasture and rangeland) in 2002 Lubowski et al, 2006). **These differences between the northeast U.S. example and the entire U.S. are striking, very important, and should be clearly stated in the text.**

Table 3-19 – it seems highly unlikely that livestock manure N exceeds total N released annually from soil organic matter in the U.S. If the median soil organic carbon content in the U.S. is about 3.23 kg/m^2 (32,300 kg C/ha) (Guo et al., 2006) for the top 20 cm of soil, and one assumes the soil organic matter C:N ratio is about 12:1, then the soil organic N content in the top 20 cm of soil in the U.S. is 0.27 kg/m^2 (2,692 kg N/ha). Assuming that 2% of the soil organic N mineralizes each year (Havlin et al., 2005; Mitchell and Everest, 1995), 301 Tg of Nr could be released annually from the soil in the U.S.

It could be argued that some Land Grant Universities in leading agricultural states may use 1 to 1.5% mineralization rates, as opposed to 2% mineralization rates, which would change the estimates shown in the table immediately below proportionately. Other universities may implicitly or explicitly assume steady state conditions for their crop N recommendation algorithms. **Regardless, the INC report should offer readers more explanation and perhaps a warning about the impact of this aspect of the Nr budget. It is strongly recommended that the**

INC report mention how the 4.7 Tg N value for soil organic matter was determined, and language should be included to point out the tremendous impact this assumption has on the overall calculation of Nr budget.

Estimation of annual N mineralization in top 20 cm of U.S. soils

All U.S land area, ha	U.S. crop land area, ha								
	(excluding forest and range)	SOC in U.S., kg/m^2	SOC in U.S., kg/ha	SOM has C:N ratio	SON in U.S., kg/m^2	SON in U.S., kg/ha	SON in all U.S., kg	**potential annual mineralization or release of SON in all U.S. , Tg**	**potential annual mineralization or release of SON in U.S. crop land, Tg**
5,594,550,000	1,091,740,000	3.23	32,300	12 to 1	0.27	2,690	1.505E+13	**301**	**59**
Ref. 2	Ref.2	Ref. 1		Ref. 3				Ref. 3 & 4	Ref. 3 & 4

SOC =soil organic carbon, SOM=soil organic matter, SON=soil organic N
Total soil N =organic + inorganic N, but organic N dominates (95% plus is organic N) (Ref. 3)
10,000 m^2= 1 ha, and 1 ha=2.47 acres
I Tg = 1 x 10 ^{12} g
approximately 2% of SOM (or SON) mineralizes annually (Ref. 3 & 4)
SOM=1.72 x SOC (Ref. 4)

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1 - Guo, Y., R. Amundson, P. Gong, and Q. Yu. 2006. Quantity and spatial variability of soil carbon in the conterminous United States. Soil Sci. Soc. Am. J. 70:590-600.

2 - Lubowski, Ruben N., Marlow Vesterby, Shawn Bucholtz, Alba Baez, and Michael J. Roberts. 2006. Major Uses of Land in the United States, 2002. Economic Information Bulletin 14 USDA Economic Research Service. http://www.ers.usda.gov/publications/EIB14/eib14fm.pdf

3 - Havlin, J.L., J.D. Beaton, S.L. Tisdale, and W. L. Nelson. 2005. Soil Fertility and Fertilizers. 7th ed. 515 pp. Pearson Prentice Hall. New Jersey.

4 - Mitchell, C. C. and J.W. Everest. 1995. Interpreting soil organic matter tests. Southern Regional Fact Sheet. SERA-IEG-6*1. (http://www.clemson.edu/agsrvlb/sera6/SERA6-ORGANIC_doc.pdf). Southern Extension and Research Activity Information Exchange Group 6

C3-62, Table 3-20 – The values for agricultural storage of Nr in soil organic matter and the annual recycling of Nr (Table 3-19) would imply that the soil system is in a steady state. Considerable confusion also arises when comparing these two tables with Tables 3-1, 3-18, and Figure 3-13. To avoid confusing and excessive repetition, consider placing the some of this information in the APPENDIX, while retaining the most significant "take-home" budgets showing Nr input and output.

C3-63, lines 14 through 20 – although we would agree with the text that there is indeed a need to better understand and to quantify terrestrial and aquatic denitrification, Figure 3-15 does not illustrate denitrification as a significant Nr loss pathway (0.8 Tg N to the atmosphere). The magnitude of denitrification N loss from terrestrial and aquatic systems is small relative to the total Nr loss to the atmosphere (9.6 Tg); denitrification

from terrestrial and aquatic systems represents only 8% of the total Nr input to the atmosphere (Figure 3-15).

There is a need for greater consistency in illustrating and discussing the Nr budgets in the INC report.

C3-67, lines 5 and 6 – the statements by Doering et al. (1999) to idle the lands with the greatest "leakage", may be interpreted as implying the need to idle the most agriculturally productive lands in the U.S. This, of course, would be absurd. Instead, there is a need to significantly reduce the N losses from the most agriculturally productive lands, which must be maintained in production to satisfy the U.S. and global food, fiber, and biofuel demand. The need to increase crop N recovery (nitrogen use efficiency) through nutrient BMPs, improved genetics, and improved cropping system management …..which was identified as "ecological intensification" …. is strongly reinforced in this section. If the most productive land were taken out of production, then more land elsewhere would need to be brought into production, which may present more environmental risks and result in even greater dependence on fertilizer and manure nutrient inputs. Clearly, existing productive agricultural lands must be sustained to help spare natural areas from conversion to cropland and allow conversion of selected lands to forests for GHG mitigation or similar environmental services.

C3-68, lines 18 through 21 – greater synchrony between N application and crop utilization is needed. Does the EPA SAB INC have a RECOMMENDATION to offer on ways to achieve this synchrony? How can the infrastructure be changed, or how can suppliers and consumers of N be motivated to change the way fertilizer N is sold, stored, delivered, and applied to fields in the Midwest (for example)…..to shift away from fall anhydrous applications to spring applications ….especially where nitrate leaching and tile discharge are key concerns? What incentives (or disincentives) can be used to alter logistics in favor of more desirable fertilizer N management practices?

line 25 – replace "Figure 3-17" with "Figure 3-16".

C3-69, lines 5 though 12 – is some text missing before the findings and recommendations? Readers are looking for findings and recommendations to change the synchrony of N application and crop use, but statements about biofuel production and lifecycle analyses are found instead. More text on these specific issues should precede Finding F3-13 and Recommendation R3-19.

C3-71, line 12 – It is important for the EPA SAB INC, and the readers of the report, to recognize that some nitrate loss via drainage will occur naturally in highly productive, fertile, high organic matter soils in the U.S. For example, in the long-term Broadbalk Experiment in England, "Even where no N fertiliser had been applied for more than 150 years, about 10 kg of NO_3-N is lost each year" in drainage water (Rothamsted Research, 2006).

C3-74, lines 9 through 25 – should these six quantification needs be developed as Findings, with parallel Recommendations?

line 5 – ammonia absorption by agricultural crops and forests also needs to be quantified, in conjunction with ammonia emissions quantification.

C3-76, lines 10-12 - Booth and Campbell, 2007 – paper appears in Environ. Sci. Technol. 41(15):5410-5418.

C3-91 – cite the source for Figure 3-17.

C3-92, lines 17 through 19, Recommendation R3-24 – is the EPA SAB INC recommending a network of monitoring efforts/sites which include simultaneous soil, water, and air measurements? Should these data be collected collaboratively and cooperatively with USDA Agricultural Research Service …… in a manner similar to the network of NADP sites or the USDA ARS GRACEnet greenhouse gas flux sites?

C3-95, Figure CB-1 – please explain "mortality" …… of fish, shellfish,…..benthic organisms, ???

C3-98 – this page and parts of this section (3.4.3) appear to duplicate (or perhaps reinforce ??) … much of the science mentioned in *3.3.1.3 Transfer of Nr to Aquatic Systems.* Please consider ways to condense and combine the information to offer a more concise report.

C3-99, line 33 – there was no mention of the possible effects of urea N discharge and the stimulation of harmful algal blooms. Should this issue be mentioned with citations like the following references? Should more monitoring and research on urea-N discharge by rivers and streams be conducted?

> Glibert, P.M., J. Harrison, C. Heil, and S. Seitzinger. 2006. Escalating worldwide use of urea – a global change contributing to coastal eutrophication. Biogeochemistry 77: 441–463.

C3-111, lines 35 and 36 – please provide a reference for this statement: "A sizable fraction of the mass of PM2.5 is condensed Nr."

C3-112, lines 20 through 31 should be included as part of the introductory material in the Executive Summary and also in the general introduction of the report

C3-115, line 40 – please define NESCAUM

C3-120, line 17 – It is also important to mention that reduced or insufficient N rates for crop production risk impairment of long-term soil productivity. Jaynes and Karlen (2005) reported that N rates below the agronomic and economic optimum could degrade the soil resource and decrease soil organic matter over time. So, care must be exercised in any N rate adjustments to protect soil productivity and to support soil resource sustainability.

C3-122, line 5 – change the Figure title from "Fertilizer application consumption in the US" to "Consumption of N-containing fertilizers in the U.S.", and also provide a reference or source citation, please.

C3-128, References for section 3.4 need to be properly alphabetized in their listing

C4-1, lines 43 through 45 – precision application of N may or may not alter the total amount of N applied to a given field. So, it may not be considered a "source limitation" per se. Instead, the technology enables a farmer to appropriate N to locations within a field that may have higher or lower N needs than the field average, and to adjust the N rate (and possibly the timing) according to crop need, anticipated yield response, and potential environmental loss.

C4-2, Table 4-1,

In the last cell in the "Source Limitation" row – insert "crop" before "yields" for reader clarity.

In the last cell in the "Improved Efficiency" row – add "education"

C4-3, line 27 – insert "point source" before "contaminants"

C4-9, line 33, Recommendation R4-3 – It seems unlikely that EPA has sufficient staff and knowledge to accomplish this objective and recommendation. It may be important to strongly emphasize the need for funding to better support state authorities in gathering and reporting fertilizer use information with sufficient county-level or watershed-level detail.

C4-9 and C4-10, Recommendations R4-3, R4-4, R4-5, R4-5R4-6, R4-7, and R4-8 -

We strongly support these recommendations and would request that the EPA INC consider including statements in the recommendations to encourage EPA to offer financial and technical support, and to help facilitate EPA and USDA cooperation with the nonprofit private sector, to accomplish these needed integrated and environmental research efforts and to provide expanded public outreach and education.

C4-11, lines 13 through 18 – the parenthetical reference to "controlled release" technologies

should be expanded to include mention of site-specific use of urease inhibitors and/or nitrification inhibitors in conjunction with the 4R BMPs (right source, rate, placement, and timing) for N-containing fertilizers.

C4-11 – line 20 - reference to a "10%" increase in corn acreage may need to be altered in order to be consistent with current acreage reports by USDA; or it may suffice to simply mention that corn acreage has increased (>5%) in response to corn market demands for biofuel (ethanol) and food.

line 34 – the Committee's recommendation ("Committee therefore recommends that policies and regulations that support implementation …….") should adhere to the "Finding" and "Recommendation" structure and formatting in previous sections of the report, so this recommendation is clearly recognized and not overlooked.

C4-12, line 15 - the Committee's recommendation ("committee recommends that a high priority be assigned…….") should adhere to the "Finding" and "Recommendation" formatting in previous sections of the report, so this recommendation is clearly recognized and not overlooked.

C4-12, line 26, line 38 – similar to the two immediately prior comments, the Committee's recommendations should all adhere to the "Finding" and "Recommendation" formatting in previous sections of the report, so the recommendations are clearly recognized and not overlooked.

C4-13, Figure 4-2 – display this figure on a separate page in landscape orientation. It is too small to be easily viewed and understood.

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Baker, J.B, G.L. Switzer, and L.E. Nelson. 1974. Biomass production and nitrogen recovery after fertilization of young loblolly pines. Soil Sci. Soc. Am. Proc. 38: 958-961.

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