

U.S. Environmental Protection Agency
Science Advisory Board
Integrated Nitrogen Committee
Final Minutes of Public Meeting January 30-31, 2007

Committee: Integrated Nitrogen Committee

Date and Time: January 30 from 9-5 Eastern Time and January 31 from 9- 12:30 Eastern Time as announced in the Federal Register on January 17, 2007, Volume 72, Number 10, pages 1989-1990. The Federal Register notice is attached.

Location: Science Advisory Board Conference Suite, Third Floor, 1025 F Street Northwest, Washington D.C.

Purpose: This meeting was held so that the Integrated Nitrogen Committee could develop a work plan for its evaluative study on the need for integrated research and risk management strategies.

Materials Available: All available materials are identified in the list of attachments on the signature page of these minutes.

Attendees: On January 30, all members except Dr. Mitsch were present. On January 31, all members except Drs. Kohn and Mitsch were present. A roster is attached. SAB Staff Office in attendance included Director Vanessa Vu, Associate Director Tony Maciorowski, Committee DFO Kathleen White, plus Thomas Miller, Holly Stallworth, Mary Belefski, and Jack Kooyoomjian.

EPA staff in addition to the speakers included: Trisha Bergmann, Rich Linthurst, Lawrence Martin, and Ed Washburn (ORD); Barry Korb and Donn Viviani (AO/OPEI/NCEE); Gail Lacey (OAR/OAQPS); Daniel Muller (OIA); and Beth Sauerhaft (OA/IO). Members of the public included Penelope Kellar (The Cadmus Group), Joseph Smith (Abt Associates) and Tamara Thies (NCGA).

Summary:

The meeting went largely according to the agenda, with the following exceptions. Dr. Jonathan Garber, Director of the Atlantic Ecology Division spoke instead of Mr. Lawrence Martin. Also, all the program offices, including Mr. Pendergast from the Office of Water, spoke before the Office of Research and Development. The EPA presentations continued to about 4 p.m. on January 30 postponing some Committee discussion to the morning of January 31. All EPA speakers provided a information about their office, either overheads or a separate description, sometimes both. These are attached to the minutes.

As an aid to the Identification and Discussion of Critical Science Issues, the chair invited each of the Committee members to briefly:

1. identify a significant nitrogen-related risk (eco, econ, people) with which they were familiar,
2. indicate whether the scientific foundation supporting that risk is good enough to recommend action to manage the risk,
3. indicate whether we know how to manage the risk,
4. indicate whether there are policy instruments in place to manage the risk, and
5. identify what risk-specific complexities exist to confound management (e.g., multi-agency jurisdiction or no jurisdiction).

The Committee considered possible suites of dates for its second and third meetings. June 20-22 and October 29-30 have been selected because there is the best attendance on those dates.

The Committee organized itself into working groups to prepare for subsequent meetings. To prepare for the second meeting, which is the first phase of the study, the members organized themselves into working groups on producers (Aneja, Boyer, Cassman, Doering, Herz, Kohn, Lighty, Shaw), system (Boyer, Dickerson, Hey, Mitsch, Mosier), and impacts & metrics (Cowling, Doering, Moomaw, Paerl, Stacey, Theis). . Leads and vice-leads were later determined for each group: Aneja and Cassman for producers, Mosier and Dickerson for system; and Moomaw and Theis for impacts and metrics.

To prepare for the third meeting, which is the second phase of the study, the Committee will organize itself into groups that address regional or archetypical systems, probably selecting three regions across the country, possibly one that is agriculturally intensive, one that is urban intensive, and one that is coastal.

To prepare for the fourth meeting and final phase the Committee will organize itself to address future trends. The Committee will address trends and existing or potential discontinuities. This phase may be undertaken by the Committee as a whole or by working groups organized by expertise well suited for the development of future trends scenarios.

Further Information on Matters Discussed:

Committee DFO Ms. Kathleen White convened the meeting, made some welcoming remarks and introduced Science Advisory Board Staff Office (SABSO) Director, Dr. Vanessa Vu. Dr. Vu thanked the committee members for their time and commitment to public service. She explained that the Science Advisory Board provides advice to the EPA, mostly peer reviews of EPA products, and that this study resulted from an initiative proposed by the SAB's Environmental Engineering Committee in 2003 which receive a lot of support. She introduced SABSO Associate Director for Science, Dr. Anthony Maciorowski and turned the meeting over to the chair, Dr. James Galloway.

Dr. Galloway introduced himself, summarized the agenda, noted that no one had requested an opportunity for public comment, and asked if any member cared to propose an addition to the

agenda. After determining that there were no additions to the agenda, he invited the Committee members and audience to introduce themselves. (The affiliations of the members are given on the attached roster and bioketches are posted at the Science Advisory Board website www.epa.gov/sab)

Dr. Galloway briefly reviewed the genesis of the study. In 2003, when the chartered SAB called for self-initiated studies, the EEC proposed a study of reactive nitrogen which the SAB selected as its top choice. EPA's Science Policy Council also supported that selection. In 2004, Dr. Galloway and selected members of the Clean Air Scientific Advisory Committee, the Ecological Processes and Effects Committee, and the Environmental Engineering Committee interacted with the EPA coordinators and others to scope the project out further. Following approval, the SAB staff began the panel formation process which ultimately produced the Integrated Nitrogen Committee. The Committee has a real opportunity to help EPA integrate it's management. Dr. Galloway's overheads are part of the record of this meeting.

The Committee can plan for another face-to-face meeting this fiscal year and twonext fiscal year. (EPA fiscal years run from October 1 to September 30.). The Committee's report has the potential to be very useful not just to EPA but to other agencies. The Committee will have the opportunity for outside peer reviewers for the report. The SAB will review the report as well. The chair's goal for this meeting is to develop a work plan because the hard work will begin when the meeting ends.

For the agenda item, Identification and Discussion of Critical Science Issues, and in the interest of helping the members get to know one another and each other's backgrounds, the chair invited each member to identify a risk that reactive nitrogen presents and to comment on the strength and weaknesses of the scientific information supporting our understanding of the risk and risk management options. The thoughts shared by members are not to be construed as the advice of the Committee, but as a mechanism for beginning a substantive discussion of the issues and allowing the members to become better acquainted with each other's expertise and perspectives. The following is a summary.

One member mentioned the role of reactive nitrogen in global climate change and thought that the scientific foundation could be strengthened by developing a better N₂O budget. Another observed that nitrous oxide is a real good integrating tool. N₂O is still a small input (2-3%) of global warming in US greenhouse warming gas budget, but much larger for countries like New Zealand. Reducing risks, as opposed to just swapping problems, involves landscape design, nitrogen fertilizer use in agriculture, reconstructing wetlands, etc.

One member thought the scientific foundation supporting risks from fine particulate matter was sound and that, while we know some things about managing the risk, it would help to know more. Policy instruments could also be improved. One complexity is that public policy is pushing biofuels, which means corn, which means reactive nitrogen. This means biofuel production needs to be managed so that it doesn't have unintended effects. The Committee needs to think about risk-risk trade-offs.

Biofuels was mentioned by several other members in slightly different contexts. One member

felt that biofuels simply had to be discussed. Another spoke more broadly of rapid changes in land use over the next decade in ways with which society has little experience. Two other members also mentioned biofuels indicating that the scientific foundation is strong enough that we know we ought to do something. There are some ideas about reducing risks. For example, if when animals are fed less protein, they excrete less reactive nitrogen. However, when starch is removed from corn to make biofuels, the concentration of reactive nitrogen in the feed that goes to the animals triples.

Ammonia was also mentioned by several members. Ammonia's impact on fine particulate matter is not well understood in comparison to the nitrogen oxides. There are no good emissions inventories of ammonia in air and a wide suite of risk management options for ammonia emissions has not yet been identified.

The risk of reactive nitrogen accumulation in groundwater was identified. Relevant data on subsurface geology are not well characterized, although data on the distribution of surficial soils have improved over the last decade. Some groundwater monitoring data are available, but are still not adequate to define the scope of the problem and trends. The data that are out there are not well integrated to provide a scope of the problem at the national scale, though some good work has been done by the USGS illustrating potential risks of groundwater nitrogen accumulation. Reactive nitrogen in groundwater can be measured and some forms of contamination can be traced to sources. For drinking water, reactive nitrogen in groundwater is only typically perceived as a problem if water is supplied to families from private wells or drawing from groundwater reservoirs. For the ecosystem, however, will need to consider effects on downstream waters and ecosystems. Because residence times of water in groundwater are long, ecosystems if reactive nitrogen is enriched in groundwater, it could take years to decades to reverse ecosystem effects if reactive nitrogen is enriched in groundwater. Residence times of water in the subsurface and associated transport of nitrogen along subsurface pathways are not well understood. Some management options exist, like changing your water supply. At small scales there are now site-specific temporary fixes like denitrification walls (subsurface). Policies are tied to land use, like Total Maximum Daily Loads (TMDLs) and agricultural policies. In any case, the approaches are on local scales, when regional or national scale considerations of nitrogen sources and fate may also be warranted.

At some golf courses and parks it appears that no nutrient management considerations are applied in design or operation. In a lot of places the excess from fertilizing homes and parks goes right down the storm drain.

Non-point sources in general are a problem and the technologies available to reduce those sources are very expensive and preventive changes, like taking people of septic systems and putting them on city sewers are needed and unpopular. This is a situation where there is a policy structure, but affordable technology is lacking.

Excess reactive nitrogen puts livability in the coastal zone at risk at a time when 70% of the U.S. population lives close to the coast. Formulating critical loads and thresholds for marine and estuarine systems is difficult because of hydrology, residence time of the water, forms of reactive

nitrogen, etc. Better information would be helpful in setting priorities for control and people need to understand it will take decades for ecosystem to recover.

The session providing an Overview of EPA's Programs on Nitrogen continued longer than planned because of the wealth of information provided and the interest of the Committee. Speakers included: Dr. Richard Haeuber, Chief, Office of Atmospheric Programs in the Office of Air and Radiation; Mr. Gilbert Castellanos, UN Program Manager, Office of International Environmental Policy in the Office of International Affairs; Mr. Jim Pendergast, Senior Engineer, Office of Science and Technology in the Office of Water; and Dr. Jonathan Garber, Director of the Atlantic Ecology Division in the Office of Research and Development

The speakers presentations are best captured in their overheads and handouts (attached), but some elements are captured here. In general, the presentations provided an idea of the structure of the office, the major pieces of legislation it implements, and which areas of the nitrogen cascade are relevant to the programs. Presenters also highlighted nitrogen-related activities of interest. Committee members asked questions and sometimes their questions and responses led to further discussion. For example, after Dr. Haeuber's presentation, Dr. Galloway asked how long it took EPA to develop NOx emissions inventories. This might give the Committee an idea of how long it might take to develop inventories of ammonia emissions. Gail Lacy of OAQPS noted that, in the 1970s, the whole idea of doing inventories was new, so it might take less time to develop ammonia inventories than it did NOx ones.

Dr. Dickerson said there is some evidence from aquatic ecosystem research that recycling in aquatic ecosystems can contribute substantial amounts of N₂O to the atmosphere. This observation was mentioned by others several times later in the meeting.

Dr. Theis asked about enforceability of international agreements. Mr. Castellanos explained that some agreements have no teeth; others are very stringent. Dr. Paerl noted the benefits of data to understand, for example, impact US atmospheric deposition might have on Canadian Maritimes. EPA and the National Oceanographic and Atmospheric Administration should play a role in the observational programs, but this should be part of the synergy Castellanos spoke of. Castellanos wondered, strategically, how they make use of the various organizations to get something done.

Dr. Aneja asked Mr. Castellanos, "Do you know, or can you find out, whether other countries have an integrated nitrogen program?" Mr. Castellanos will look and observed that the Netherlands seems to track everything. Aneja also asked, since we make information available to various other organization, "Is it possible the information the Committee develops could be of use to others?" Mr. Castellanos sees a possibility that a report that says, "This is how we can reduce impacts of reactive nitrogen, could be very helpful"

Dr. Moomaw reinforced that, while reactive nitrogen plays a role in many many environmental programs, it is mentioned in very few agreements. It is mentioned in Kyoto, but not Montreal, and in nothing to do with biodiversity. There is problem after problem where reactive nitrogen is an invisible component of a significant problem. This might be one or the points the Committee makes.

Dr. Cassman proposed that with Castellanos and Moomaw's help, the Committee could list environmental concerns that are in process or existing. The Committee could identify where reactive nitrogen has a big role to play to help convince people that reactive nitrogen is driver.

After Mr. Pendergast from Office of Science and Technology in the Office of Water spoke, Dr. Boyer asked whether a TMDL is only developed if streams have been identified as being impaired, and what the relationship was between TMDL and nutrient criteria. Mr. Pendergast responded that, when a water is impaired, the state needs to figure out, usually through field studies, what the causative agent is. TMDLs are usually developed when a water is impaired, although it is possible to develop them otherwise. Dr. Boyer is interested in the relationship between reactive nitrogen and phosphorous, because the management approaches are quite different. If we do all this work on reducing risks from reactive nitrogen, independently of phosphorous, we might be missing an opportunity. Mr. Pendergast observed that much of the mid-West thinks that, if they control phosphorous, their nutrient problems will go away. EPA encourages states to look at both so they don't trade one problem for another and also because of impacts downstream waters. States are resistant but he thinks addressing reactive nitrogen and phosphorous together may offer some lower cost solutions.

Dr. Paerl thinks the relationship between reactive nitrogen and phosphorous is important. It relates to scaling and to total effects of reactive nitrogen. In North Carolina, rivers turn into estuaries. In the 1960s, they focused on phosphorous and got rid of the algal bloom problem, but – because the blooms had taken up reactive nitrogen that is now available further downstream – there are now reactive nitrogen caused blooms in the estuaries.

Mr. Stacey, who works for the Connecticut Department of Environmental Protection's Bureau of Water Management, found Pendergast's presentation on target and realistic. He thinks early progress was easier than current options. The remaining sources are very difficult to control. He asked Mr. Pendergast whether he saw trends. Each part of the Clean Water Act has provisions for exceptions like use attainability analysis. Use attainability analysis acknowledges that sometimes you can't get there. The law recognizes six of them, one of which is economic. Humans have made such an impact on the landscape that it is not entirely reversible. There's a big bank of nutrients in the soils and sediments that it will continue to leach out even if loadings stop today. Mr. Pendergast observed that an attainability analysis is a lot of work; an ecoregion by ecoregion approach might be easier than water body by water body. Georgia is working on a lake by lake approach; if they see patterns developing, they might move to an ecosystem approach.

Dr. Theis asked whether, once a determination has been made that reactive nitrogen needs to be limited for a particular waterway, EPA has a prescription for how that would happen. Mr. Pendergast says EPA provides technical information, but does not decide how the state(s) should solve the problem. Dealing with reactive nitrogen and Phosphorous at the sources is considered.

Dr. Cowling noted that California leads the way in air quality. Are their exemplary states in water quality management? Pendergast said yes, but he isn't sure how to identify them. Some states excel in one area, but not in others. He knows of no clear overall leader.

Mr. Stacey asked how EPA anticipates encouraging all the states in the Mississippi drainage area to cooperate in reducing the dead zone. Mr. Pendergast responded they have various tools: meetings, training, etc and even an EPA declaration that the state programs are inadequate to protect the Gulf of Mexico and writing a rule. Most of the hypoxic zone is not in Louisiana waters, but in federal waters. Clean Water Act (CWA) protects state waters, but its role in protecting federal waters is less clear.

Dr. Garber has been involved in trying to create a focus on nitrogen-related activities in EPA for fifteen years. He has a long professional and organizational interest in this issue, but has learned that nitrogen does not get people excited in a policy setting. He explained that ORD does not have a direct line to legislation. It is the science arm of the EPA with 2000 employees in a dozen research facilities organized on the risk assessment paradigm charged with providing models, data and methods so the program offices can make the best decisions. He referenced the "Snapshot" handout which is a collection of *ad hoc* projects that relate to nitrogen, but stated that ORD does not have a "nitrogen program" as such.

The tendency when thinking about integrated nitrogen is to emphasize what is known about reactive nitrogen. He feels he has fallen down by not emphasizing integration. What is an integrated nitrogen program? Even if it is just research, what does integrated mean? Nothing allows us to go from air to water in the management of this pollutant. This morning's discussion of reactive nitrogen losses through de-nitrification was very interesting, but most reactive nitrogen is lost from upstream to downstream, ending up in the ocean, usually eutrophying the coastal zone. This means scale must be considered. Yet the tools needed for a discussion of a management structure that could address reactive nitrogen at all those scales are lacking.

ORD is interested in the issue of multiple stressors. EPA has focused on chemicals, toxic chemicals in particular. Yet, if EPA cleans up the highly contaminated New Bedford harbor through Superfund, it will turn green because it is loaded with nutrients. It is not green now because the toxic chemicals are suppressing normal production.

Because it can't monitor everything all the time, EPA puts a lot of effort into developing statistically sound monitoring strategies and passing them off to the states. Reactive nitrogen measurements are included. It would be nice if they could identify classes of lakes or streams that followed similar patterns. There is interest, but not real progress, in that sort of classification.

Dr. Galloway asked about time frame for development of a reactive nitrogen research program. Dr. Garber responded that they'll either get a concept in weeks or months or the opportunity will pass them by. It will then take up to 12 months to develop, after which it could have a long life. Although, the nature of the reactive nitrogen problem hasn't changed that much, recognition of dead zones like the one in the Gulf of Mexico has raised awareness. Some of the science that Dr. Galloway and others have done to provide reactive nitrogen budgets makes the case for an integrated reactive nitrogen program stronger. The fact that nutrients keep popping up as a major source of impairment of state waters is also important. OW has required development of nutrient criteria, which means science is needed to support that. He doesn't think there is a single over-

riding reactive nitrogen problem because, if there was, Congress would tell EPA to address it. He thinks it is just lines of converging evidence.

Dr. Haeuber, from OAR, observed that what has changed is that there is more awareness of Western ecosystems sensitivity to reactive nitrogen deposition. It isn't just acid rain in Eastern forests, reactive nitrogen is a problem all over the country.

Dr. Hey asked what Congress knows about reactive nitrogen and why, if EPA is the defender of the environment, why isn't it putting information before Congress? Perhaps EPA is doing so, but not very effectively. The earlier EPA efforts to get an integrated reactive nitrogen program did result in some research. It is not the role of career civil servants to "get in the face of Congress", but the political appointees can. Dr. Hey asked if there was a bibliography of research done by EPA on reactive nitrogen. Dr. Garber thought not and suggested a search of the Science Inventory. He reminded the Committee that there is no reactive nitrogen program.

Dr. Moomaw agreed reactive nitrogen doesn't make it onto the "WOW meter" because it seems so benign. It's even hard to get people to think badly of carbon dioxide. This is because the bad effects are several steps down from the discharge. He asked, "If EPA focuses on risk assessment, how are risk assessments used to set priorities for risk reduction and risk management actions?" Dr. Garber replied that is a little outside his area. Generally it seems like the risk assessment informs the EPA which then develops appropriate actions. Dr. Linthurst confirmed that.

As an example, Mr. Pendergast spoke about surface water protection. Periodically, they look for new information on contaminants and decide whether their criteria should be done. They set priorities, in part, based on what they think they can get done. When deciding which industry to look at, they consider both risks and mitigating technology. SABSO Associate Director for Science, Dr. Maciorowski reminded the Committee that the criteria are not enforceable; they fit into standards about particular uses. Dr. Haeuber described a similar process is involved in revising the National Ambient Air Quality Standards (NAAQS). The National Center for Environmental Assessment (NCEA) works with Office of Air Quality, Planning and Standards to bring all the science together, synthesize it, and then review the NAAQS to see if it should be changed.

Mr. Stacey sees a world of difference between toxic parameters with thresholds and other contaminants. He thinks reactive nitrogen has a broad range of upsets, so the kind of science that goes into toxicity assessments could be used for nutrients instead of the statistical approach EPA took. Should something be done differently in how reactive nitrogen and phosphorous criteria are set?

Dr. Garber said that Stacey is correct that the toxic chemical risk assessment paradigm is very effective. The challenge is to see how it could be applied to something that has so many beneficial effects. His lab has been looking at loading-response effects in coastal water. The ecological theory is sound.

Dr. Boyer asked whether the *ad hoc* research projects feed back into multi-year plans. Dr. Garber responded that, in theory, everything links back to some strategic goals in a directly traceable way. How does the reporting go back to water and air, like about developing river and lake classification systems? Mr. Pendergast responded that he and Dr. Garber work collaboratively because that's how the program offices get the best use out of the support ORD can provide. Dr. Garber said there is a whole structure, with a staff, to provide a good liaison between the research projects, the program offices, states and regions.

In the context of risk assessment, Dr. Cassman noted that EPA, like everyone else, is using more and more models. Then he asked about models and about uncertainty, both model uncertainty and output uncertainty. Dr. Garber responded that there is everything from home-grown models where ORD writes the code onwards. The program includes every conceivable way a model can be developed. Dr. Cassmann asked what constitutes acceptance of a model? Dr. Garber responded that every modeling group he has been involved with has had a peer review group intimately involved in development. Mr. Pendergast said the answers will be program specific. Within the water programs, 90% is out of the TMDL program. OW does not have a model acceptance protocol. They look at the origin of the model, its pedigree (for example, has it been tested and used in other places or is it unique to this application), calibration, data, uncertainty, etc.

SABSO Director Dr. Vu said EPA has developed a guidance document on regulatory environmental modeling. The SAB's Regulatory Environmental Modeling Guidance Review Panel reviewed the EPA's *Draft Guidance on the Development, Evaluation, and Application of Regulatory Environmental Models and Models Knowledge Base*. Dr. Theis chaired the review. and the EPA has revised the guidance in response to the SAB's report. The SAB's report and materials relating to the conduct of the review can be found at <http://epa.gov/sab/panels/cremgacpanel.html>. More information about EPA's Council on Regulatory Models can be found at <http://cfpub.epa.gov/crem/>.

Dr. Paerl said that, in terms of visible issues, harmful algal blooms is probably the one most closely linked to reactive nitrogen, even more so than hypoxia. The reactive nitrogen issue that almost everyone knows something about is the blooms. Dr. Garber said the issue has to resonate across the EPA or it won't fly; if it is going to be a multi-media program, it has to have multi-media appeal.

Mr. Herz says there is a Congressional Research Service research report on hypoxic zones that came out recently. The interagency Oceans Commission Report looks at funding requirements for research.

After the break, Dr. Galloway reminded the Committee that, tomorrow morning, they would plan out their two years of activity. This afternoon, he would be interested in hearing what they learned about the objectives, where the disconnects are and next steps.

Dr. Doering noted that reactive nitrogen is a very difficult apple to slice. Dr. Garber commented that there was no dovetailing of the regulatory structure, reactive nitrogen is never lost, and the time and spatial scales. Dr. Doering wonders how to slice the apple so the importance of time

and space are understood. Also, how much is too much? You might need to have separate criteria for different end uses. Dr. Moomaw built on this. He was at a meeting of state governments and governors of German Laender. The Laender governors were able set different standards for the re- use of contaminated land depending on the new use because they were sure they could control the use. The American governors, in contrast, were more comfortable with one standard everywhere the same.

Dr. Aneja observed that there appears to be no clear understanding of the inventory of emissions of biogenic materials; and there is no clear understanding of the ultimate fate of reactive nitrogen. He would like to know more about these issues.

Dr. Boyer thought it would be interesting to hear what non-Committee audience responses to objectives. She thinks a whole lot is known by some staff members in the EPA about the problems and linkages. Dr. Maciorowski reminded the Committee that this is an SAB project. The reality is there is no formal reactive nitrogen program. There are formal reactive nitrogen regulatory programs based on legislation. Work years and dollars are shrinking. Reactive nitrogen was recognized as a problem thirty years ago and still is. It's like a cloud, you can see it, but it is hard to grab onto.

Dr. Kohn asked what information EPA could actually use. Dr. Maciorowski talked about EPA's legislative responsibilities and its opportunities as a credible convener. Complex environmental problems are not the purview of any one office. The Committee could identify things that could be done now and some that could be done in the future, things that could be done by EPA alone or collaboratively.

Dr. Garber says that, because of all the expertise in the EPA, EPA has a nearly unique ability to take a multi-media approach to a problem

Mr. Herz seconded Aneja on the atmospheric data and suggested the Committee invite the National Acid Deposition Program to speak on the data and trends, likewise the Conservation Effects Assessment Program at USDA. The larger problem is that the reactive nitrogen issue is multi-faceted and control strategies are source-specific and in agriculture, site-specific. Perhaps the Committee should build a matrix that generally describes the problem, whether reactive nitrogen is primary or a secondary contributor. He tends to understand things visually and would like to see it mapped out. He asked whether there was anything that could be said today that would reduce reactive nitrogen impacts in the atmosphere. He would think having each person reduce their own energy consumption is very valuable. Hence increasing efficiency in all our systems could contribute to reducing risk from reactive nitrogen. Dr. Haeuber kindly offered to help orchestrate a presentation on acid deposition (dry deposition, rural monitoring , etc.)

Dr. Hey would have liked an assessment of the significance of the problem by the EPA speakers. DFO Ms. White said that it would be useful to specify these questions tomorrow morning. Dr. Haeuber observed that, if there's a program, you can assume it's significant.

Dr. Moomaw noted that, in the beginning, people addressed the symptoms of environmental pollution. For example, if there was an algal bloom, people used herbicides instead of looking

for the underlying cause. In the early days of environmental protection progress could be made in a piecemeal fashion. Now we need to take a larger look at the problems. The Committee could make a real contribution by providing a structure that integrates these factors so that, if you wanted to stop 30-40% of the reactive nitrogen coming into the Chesapeake Bay through the air, you could see where the opportunities are. Even if they took conceptual models, like the flow models, and identified the most effective points in those models to make interventions it would be a contribution.

Dr. Cowling thinks the comments made already suggest the audience for the Committees report is EPA. We should think more broadly, especially if EPA does have a role as a credible convener.

Dr. Maciorowski suggested organizing by what do we know, what don't we know, what are the gaps, what are the programs, how can they work together better.

Mr. Stacey thinks the cascade should be the organizing model, but will need to get into each compartment to identify points of intervention. Some can be very proximate, like wastewater treatment plants (WWTP), others, like energy efficiency are more remote. The Committee can make judgments on where the science is good enough and set priorities. Once that's done, he likes the matrix idea. If NO_x emissions must be managed to reduce ozone exposure in humans will it be good enough (or not) to protect fish in Long Island Sound as well?

Dr. Paerl observed that one of the really exciting things about this project is that the excitement and frustration is that reactive nitrogen is at the edges of both the science and the media.

Dr. Cassman thought a compelling story could get people excited about reactive nitrogen. Mr. Stacey finds reactive nitrogen exciting because of the intersections. To be helpful, the Committee needs to build a persuasive case that there is an emerging compelling story not adequately addressed by current programs and structures. What's the real progress over the last 10-20 years in each of the boxes in the cascade? He thinks the environment is on the cusp of a discontinuity in global reactive nitrogen cycles because energy prices have been driven so high that energy from agriculture is looking attractive. Only five years ago he and his colleagues thought about developing fertilizer guidelines for reactive nitrogen that took into account the ratio of fertilizer to corn prices; now agricultural products are being priced like energy. He spoke about Millennium Assessment, food production, and ecosystem services assumed the real price of food was constant or dropping. But the price of corn doubled this year. The modeling doesn't even cover the reasonable scenarios of what could happen.

Dr. Theis asked if the Committee could do a reactive nitrogen source and control analysis for any region using existing or soon to be gathered data. What about uncertainty?

Other observations were that the Committee can bring in other expertise and that case studies are important. Dr. Doering observed that case studies should tell how location is critical. Dr. Pearl said that the spatial dimension is needed, upstream v down. This can be handled with a case study.

Dr. Galloway proposed using the nitrogen cascade as an organizing principle for the Committee's work. (See cascade paper or illustrations in his presentation overheads.) Dr. Cassman asked whether the cascade was the picture or the chart and Dr. Galloway said both. A member suggested adding a box for about mobile sources and power plants. Dr. Hey suggested adding an "urban" box for wastewater. A relatively large percentage of total fertilizer nitrogen used in the US goes onto the urban landscape – the actual amount of nitrogen applied to the urban scene needs to be quantified as well as the fate of the N considered. Dr. Doering thought the cascade might read easier as a PERT chart and observed that, since you never get rid of reactive nitrogen, you might need to show multi-cycling with red dots. Dr. Cowling noted everyone agrees on the concept, but if each member drew the diagram, each would have something different – like the New Yorker's map of America. He thinks there is some benefit to having several "drawings of the elephant" How much do Americans spend feeding themselves, as opposed to transporting themselves. It will show up our biases.

Dr. Moomaw remains concerned about metrics and impacts.

Dr. Garber noted that the risk assessment construct is another way of organizing the material. It can help identify sources and effects. Maciorowski said the ecological risk assessment paradigm is about fifteen years old and has served the ecological community well. SAB's Committee on Valuing the Protection of Ecological Systems and Services (CVPESS) is beginning to change that problem formulation mode to incorporate economic issues. One could also think in terms of a dollar cascade and/or a management cascade showing that problems magnify as they go downstream.

Dr. Galloway proposed dividing the Committee into working groups so they can make more progress. Dr. Doering thinks they need to get a better handle on the cascade first and have overlapping membership. Dr. Cassman recommended groups multi-disciplinary working groups. Dr. Galloway asked them to think about it, think about what group they'd like to be one and who they'd like to work with.

Dr. Cassman would like it if folks would identify places where they thought data existed to give current trends. He has not seen nitrate concentrations in the Cedar River outside of Iowa over the last 30 years and it would be helpful also to see key health or eco indicators for which trends could be established.

The Committee recessed at 5:00 p.m. and resumed at 9:10 the following morning. Various members had provided materials to be copied and distributed or used as overheads in small presentations that morning. These are identified on the list of attachments below.

Dr. Galloway reminded the Committee that this morning they would address:

1. What do we add to conceptual cascade diagram?
2. What metrics should be used?
3. What group do you want to be in?
4. How would you expand the conceptual model to take into account the important issues in your sub-system?

5. What information do you need for your group? Whom would you like to hear from?
6. Where do you think data existed to give current trends on indicators?

Dr. Cassman emphasized the need for a series of metrics that are the best descriptors of reactive nitrogen trends and that incorporate drivers and consequences.

At Dr. Galloway's invitation Dr. Linthurst (ORD) told the Committee that the EPA is preparing an informational "background" on nitrogen to bring the Administrator up to speed. This is an indication of increased EPA interest. Dr. Barry Korb (AO/OPEI) said that he is the coordinator; he had not mentioned this as the final memo has not been signed. Dr. Linthurst was interested in some SAB involvement and Dr. Korb indicated he would be willing to explore this. SABS Director Dr. Vu mentioned that she had briefed the Administrator on the Committee's work and that he was very excited about it.

The final presentation providing an Overview of EPA's Programs on Nitrogen was given by Mr. Robert Bastian, Senior Environmental Scientist, Office of Wastewater Management in the Office of Water. His overheads are the best source of information on his presentation; they are attached. Basically, he sees wastewater treatment plants as integrators. Now publicly-owned treatment works (POTWs) are split almost 50/50 between secondary and advanced treatment (of which nutrient removal is a part – 2500 have total phosphorous limits, 500 total nitrogen, some with ammonia which is removed by converting to nitrate).

Dr. Moomaw observed that three-quarters of American's are served by public wastewater treatment facilities. There are only a handful of privately owned municipal WWTP. About a fourth of the population uses on site systems. There are now advanced capabilities for on-site systems so that you can reach secondary quality or even advanced wastewater treatment (AWT) if you are willing to put some effort into operation and maintenance, but these have not been widely adopted. Dr. Hey reminded people that wastewater treatment takes energy and produces sludge.

Mr. Bastian presented a slide of what happens to reactive nitrogen and said there have been closed mass balances for reactive nitrogen in WWTPs. Dr. Galloway noted that reactive nitrogen that is not converted to nitrogen gas is still reactive and potentially a problem. Mr. Bastian responded that if you can use it, perhaps in the form of sludge, to reduce fertilizer use, you can still make a difference. However, sewage sludge only has the capacity to replace 2% of fertilizer use and there are practical problems moving it around.

Dr. Theis thanked Mr. Bastian and spoke of forces in society that limited the Phosphorous that would get to wastewater, such as limiting phosphorous in detergent. He asked if there were similar forces relating to reactive nitrogen. Mr. Bastian said their source control programs related to TMDLs, but he knows of nothing analogous to the detergent strategy for reducing phosphorous in rivers and lakes. There is no Congressional driver saying they have to set water quality standards to protect the Gulf of Mexico.

Dr. Galloway spoke of the scale of the problems, then Dr. Moomaw and Mr. Bastian discussed land-use systems to handle wastewater treatment. It would take all the land in two counties to deal with Cleveland's wastewater. You see these projects happen where there is available land and where there is a need to polish to meet drinking water standards. Dr. Cassman made an analogy to the Land Grant institutions and suggested that the land be dedicated where development is to be expected.

Mr. Stacey mentioned that the need to protect natural wetlands creates some difficulties in using them for waste water treatment

The Committee then turned its attention to Planning of Future Meetings

The initial discussion revolved around an organizing paradigm for the Committee's work. Dr. Galloway displayed to his revised overheads, reviewed what the Committee did yesterday to identify issues. In response, he had updated his drawing, for example to add transportation, energy production, and sewage. Dr. Shaw noted that lawn, urban parks and golf courses still need to be added.

Dr. Theis noted that Mr. Bastian's presentation was organized around risk management and pulling reactive nitrogen out of water where it causes the greatest mischief. Dr. Theis is not sure that the Committee has made the leap to the risk-based paradigm, and perhaps it shouldn't, but it should be discussed and decided. Dr. Theis suggests the Committee also hear from producers of reactive nitrogen who are probably not interested in risk, but in satisfying demands.

Dr. Shaw believe the cascade will be helpful to the Committee in doing a thorough job, but that writing in terms of the risk paradigm may be necessary to meet the needs of their audience.

Dr. Moomaw reminded Committee that, if they are going to think about risk, they need to think about all the risks, not just those in EPA's risk management paradigm. If you don't consider the risk framework farmers are operating in, for example, you won't know where the levers are. Dr. Doering thinks the Committee should speak with those that EPA will have to work with. Agriculture and Energy will have very different views of risk than EPA. Also, he asked, "Are we dealing with an elephant or a breadbasket?" Reducing 5% by 50% is not as valuable as reducing 30% by 10%, for example.

Dr. Hey finds the cascade helpful; but he thinks it would be more helpful to be re-drawn into emitters, transporters, and processors. This would help the Committee understand the scales. He is particularly interested in the role of natural processes.

Dr. Galloway responded that yesterday, Cassman had noted the value of adding numbers to the diagram. Dr. Boyer and colleagues will create a nitrogen budget for the US that will fit into the cascade. This will allow the Committee to get at some of the chain – transfers through urban, agriculture and some other sectors. It's a full budget. She is also able to generate budgets at a regional level.

Dr. Cassman thinks that the cascade allows them to look at trade-offs. Perhaps it is better to have several diagrams than to try and put everything in one. Identifying mega-trends that will have influence on that chart, like bio-fuels, would be valuable. Dr. Galloway spoke of identifying choke points, as well.

Dr. Hey noted that Dr. Galloway has that perspective, but he himself doesn't get it out of the drawing.

Dr. Lighty doesn't know if the real choke point is energy or agriculture.

Dr. Paerl spoke to processes and trade-offs, suggesting that incorporating a spatial element or developing a different diagram that addresses it. Dr. Hey thinks this is how you get at transporters. Streams that process non-point source (NPS) v atmospheric inputs, for example. As you get closer to the coast the proportion changes.

Dr. Shaw thinks it would help to get at least an order of magnitude scale on the sources (with uncertainty) to put the right perspective on things. Mr. Herz agrees with Shaw, but doesn't want to aggregate too much because agriculture's contribution to a water-shed can be minor or major. In three counties feeding to the Chesapeake Bay, there are a lot of animal nutrients from animal feeding operations (AFOs) and chickens. Some of them are being shipped to Arkansas. Although there is pressure for a federal directive to apply them on federal lands, such as highway right of ways, it may not be smart to put them next to impervious surfaces with big storm drains.

Dr. Cowling asked, who is the audience for this report? He recommends thinking much more broadly than EPA. The Committee may need to educate itself more thoroughly about the needs of other audience to ensure that EPA can cooperate with others (not just agencies) with whom EPA has to cooperate. Perhaps we should hear from agriculture, energy, and transportation, not just federal agencies. Show them this diagram and ask them what they think.

Dr. Dickerson addressed aggregating and scaling. We need to ask ourselves which species, which problem. Sometimes we will need to aggregate, sometimes not. EPA is already doing a lot of good work. Although the Committee could reproduce diagrams, EPA has good ones. The Committee should focus on the linkages. Maybe the audience is much larger than just EPA. Some things are straight-forward, like NOx emissions from utilities. The utilities don't make anything by discharging NOx; it might cost them something to remove it, but they don't benefit from it. The fertilizer industry, on the other hand, does make money by fixing nitrogen. He advocates focusing on where limits can effectively be set.

At 10:30, Dr. Galloway did a process check. He agreed the audience is beyond EPA, but it is first of all EPA. We can invite people, but we do need to specify what we want to hear from them. The Committee need to think about risk, as Dr. Theis indicated, and needs to form working groups. The Committee agreed groups were needed, but it was not immediately clear how best to organize.

Dr. Hey advocated four groups: emitters (numbers and scale), processors, and transport (potential, scale, and what is delivered), exchange between land and atmosphere. The intent would be to better show the movement from reactive nitrogen to nitrogen gas

Dr. Pearl added effects. Dr. Hey saw effects as a separate group, but Dr. Paerl thought it could be moved in with transporters.

Dr. Theis mentioned the life-cycle approach: inventory, impacts (risk), improvements. This approach allows rankings and can still be subdivided into the groups Dr. Hey mentioned. This life cycle approach ensures the Committee would cover all the bases.

Dr. Vu shared some thought based on the struggles of different committees to complete their work, observing that CVPESS has been working for years and has gone down some dead-ends. It is important to think from the beginning what the audience and messages are. Each Committee member already has some good ideas. The Committee could work backwards, thinking first about what it wanted to say and then how to support it, instead of taking a systematic approach.

Dr. Vu reminded the Committee that SAB serves EPA and that EPA is the primary audience.

Dr. Moomaw noted that some emissions cause much more damage than others, so tonnage alone won't give you your priorities. Sometimes a small amount of pollution in a very vulnerable place is much more troubling than the bulk. This gets back to the metrics question. Society values human health highly, which is why air emissions get so much attention. Mr. Herz agrees. Dr. Moomaw was not sure whether this would fall into the transporters group proposed by Dr. Hey. Dr. Hey thinks it could go with the separate group Dr. Theis suggested on impacts.

Dr. Mosier would like to see the assessment as part of the committee's work, observing that it is hard to make some of the judgment calls. Dr. Moomaw responded that, even if the Committee can't make the determination itself, if it develops a good process for doing so that would be useful to EPA.

Dr. Galloway recapped the available organizing schemes:

1. By EPA Structure
2. By media
3. By flux
4. By life-cycle approach

Dr. Cassman thought there might even be a group on megatrends for the future. Mr. Herz volunteered a presentation on fertilizer trends at a subsequent meeting.

Dr. Galloway suggested he meet with Drs. Cassman, Hey, Moomaw and Theis on break to discuss organizational options to present to the full Committee. After break, Dr. Moomaw presented the proposed organizational scheme, observing that time, scale, and trends are complicated. They decided they couldn't have the same structure throughout the process.

Initially, three groups would work at the national level to prepare for the next meeting. These groups would be:

1. Producers
2. System (how things fit together and how to work on them)
3. Impacts and Metrics

In the second phase, working groups would look at regional or archetypical areas, selecting three regions across the regions, perhaps agriculture intensive, urban intensive, and coastal. These working groups would do the preparation for the third meeting.

In the final phase, the Committee would address future trends by projecting ahead and considering what trends are we on, keeping in mind that discontinuities occur. At this time it is not clear whether the Committee will undertake this as a whole or divide into working groups, possibly organized by expertise that could develop future trends scenarios.

Discussion followed. Drs. Doering and Lighty like it. Dr. Vu liked the idea and recommended use of case-studies as examples. Drs. Hey and Doering say case-studies will come into the second phase and Dr. Moomaw assured her there were good story-tellers around the table.

Dr. Shaw observed that the second phase could provide an opportunity to talk about some border transport issues as another way of addressing some international issues. Dr. Cassman noted that there are clear international factors within North America, for example, biofuels, food supply, where food will be grown and who will grow it. Dr. Dickerson told the Committee, if it only focus on the US, it will be wasting its time with regard to N₂O.

Dr. Dickerson asked if phase 3 would include a global perspective. Dr. Galloway said it could. Mr. Castellanos was not sure he wants to address the nitrogen cycle in Asia and it's impact on the U.S. Dr. Doering responded that there are some "elephants" that can be named, for example, the nitrogen that is coming off of rice, addition of a power plant a week. Such examples provide a sense of scale.

Dr. Mosier did not have strong feelings on whether international issues were considered in Phase 2 or Phase 3. Dr. Galloway thinks this can be decided at a later time.

Dr. Cowling raised the issue of audience. Dr. Doering thinks the proposed organization automatically widens it so that the Committee can speak to a wider audience through examples and trends.

Dr. Hey thinks Congress and state legislatures are important, maybe even more important than the general public. Dr. Galloway expects that the final report will become public in late 2008 or early 2009. Perhaps some of the Committee's early work can contribute to things like "backgrounder" on nitrogen that Barry Korb (AO/OPEI) is coordinating.

Dr. Galloway then directed the Committee's attention to question #3, "Which group do you want to be in?" The working groups can articulate what information they want for the next meeting

and describe what they can do to prepare for the next meeting. Committee members volunteered as follows:

1. Producers: where is the Reactive nitrogen coming from? (Doering sees choke points as the dividing line between producer and system groups)
Aneja
Doering
Herz
Lighty
Shaw

2. System: how is Reactive nitrogen moving through the system and being denitrified? (how things fit together and how to work on them)
Boyer
Dickerson
Hey
Mitsch (assigned based on expertise, not present at meeting)
Mosier

3. Impacts and Metrics
Cowling
Doering
Moomaw
Paerl
Stacey
Theis

Unassigned: Cassman, Kohn

Some adjustments were made to assignments after the meeting and leads and vice-leads assigned.

At 11:40, Dr. Galloway asked for a five minute discussion on the charge to each group, beginning with the Producers. He asked what will happen between now and next meeting? Dr. Aneja thinks they should quantify, with error estimates, reactive nitrogen emissions within United States. Dr. Shaw suggested the Committee identify stakeholders it needs to consider and perhaps with interact with.

For Systems, Dr. Dickerson suggested the working group identify and quantify fluxes with uncertainties and which can be considered as in steady-state. Dr. Hey suggested meeting with U.S. Geological Survey water people who have worked a lot on nitrogen flow. (Dr. Boyer could also contribute here.) By next meeting they should have a map of the nitrogen load moving through the water system in the US, where it comes from and goes to, and forms. Dr. Boyer offered to pursue new SPARROW model estimates from USGS colleagues. Dr. Mosier asked if there are atmospheric equivalents. Dr. Aneja is not sure scientific community has a good handle on the transport of reactive nitrogen from concentrated animal feeding operations to surface and

groundwater. Dr. Dickerson says the error bars are large and emerging issues are a problem. Dr. Theis said this gives the Committee an opportunity to identify data gaps.

For Impacts and Metrics, Mr. Stacey think first about effects and relationship of stressors and impacts with respect to reactive nitrogen enrichment, thresholds and regulatory thresholds, what can be done, including management practices. Dr. Cassman asked this working group to give some indicator of importance to quality of life in 2-3 decades and identifying the important ones. Dr. Theis spoke about the tools for assessment. Dr. Paerl observed that, once they get into effects, it will be more obvious which will be the big ones down the road: hypoxia, fisheries, human health. Scales of effects are really important. Dr. Boyer thinks it is valuable to mention where in the cascade is related to the impacts. Dr. Dickerson asked if group 3 would discuss biodiversity and criteria pollutants? Dr. Moomaw said yes and, also, human health (although they might needs some help) which is one of many important measures. There is value in pulling all the measures together in one place.

Then Dr. Hey asked about fact-finding. Dr. Vu reminded them that everything has to go through the DFO. Working groups is the term of art. DFO can schedule conference calls. The next face-to-face Committee meeting can be extended to allow for breakout sessions. She does not anticipate face-to-face working group meetings.

Dr. Galloway will send out rosters, button-hole chairs, and provide charge.

Dr. Galloway then directed them to the calendar for the selection of meeting dates. After some discussion the following suites of dates for the second and third meetings were identified as possible:

May 14-16	Lighty and Stacey not available
June 6-8:	Doering not available
June 20-22:	Works for all present (Lighty can only do 21-22)
October 15-17	Works for all present
October 29-31	Works for all present and is better for Paerl

After checking with absent members, the dates June 20-22 and October 29-31 were selected.

At noon, Dr. Galloway asked the Committee whether they would prefer to end the meeting or talk about additional issues. Further discussion followed.

Dr. Aneja asked for clarification about outside speakers. Dr. Galloway responded that each working group will identify outside speakers and what they will be asked to address in some specifics.

Dr. Vu suggested that, in planning for next meeting, after the chair gets input from the three groups, the Committee have a planning conference call to make sure everyone is on the same page. This should be done early enough that she has time to do the travel and invitations, which would mean knowing by April who should be invited for a June meeting. Dr. Galloway

suggested aiming for a conference call of the Committee before April 15 at which the three working group leaders will report.

Dr. Dickerson asked whether we would like to look at a time line and the suggestion was accepted.

Dr. Cowling noted that the Committee finds it easier to think in EPA organizational terms and that, although it is very easy just to think about detrimental effects, the Committee also needs to think about benefits of food, transport, energy quality of life issues.

Dr. Dickerson presented a NO_x control time line from 1953 when Haagen-Smit figured out that London Smog and LA Smog were different to the decrease in US NO_x emissions after 1994. See his handout. This suggests it may take decades before ammonia can be effectively addressed.

Dr. Galloway noted that NO_x is all point source or mobile source. Ammonia, on the other hand, is an area source. He asked Dr. Dickerson how he would present this timeline to EPA and Dr. Dickerson said there is about a 15 year lag between state of the science and state of the policy. Dr. Aneja thought 15 years was a minimum because NO_x was a NAAQS pollutant, and ammonia is not a NAAQS. Dr. Dickerson also said they went down the wrong path (hydrocarbon control) for some time.

Dr. Paerl spoke about the relationship of primary production and inorganic nitrogen input to coastal systems. Drs. Aneja and Dickerson asked when it flattens out and the answer is no one has taken it that far yet. Dr. Paerl says this is the most compelling big picture illustration. Dr. Vu thanked Dr. Galloway and the Committee. She enjoyed the discussion appreciates their time and commitment. The meeting was adjourned at 12:30.

Respectfully Submitted:

Certified as True:

_____/s/
Ms. Kathleen E. White
Designated Federal Official

_____/s/
Dr. James N. Galloway, Chair
SAB Integrated Nitrogen Committee

Attachments: Except for the items noted, these attachments will be made available at the SAB website. Copies of all attachments will be found in the FACA file

Federal Register notice
Final Meeting Agenda
Final Roster of the Panel
Sign-in Sheets from the Meeting *
Email from DFO to Committee January 17, 2007

Overheads used by the chair January 30 and 31

1. As of January 30
2. Revised for January 31

Overheads used in EPA presentations

1. Haueber
2. Castellanos
3. Pendergast
4. Bastian

Materials provided by the EPA

1. A snapshot of ORD Research Activity on Reactive Nitrogen
2. OAR Nitrogen Control and N-Related Programs
3. Acid Rain Program 2005 Progress report (offered, not distributed)
4. NOx Budget Trading Program: 2005 Program Compliance and Environmental Results (offered, not distributed)

Overheads used by Committee members in presentation & Related Item

1. Dickerson
2. Paerl
3. Stacey

Papers distributed by Committee before, at, and slightly after the January meeting

1. The Nitrogen Cascade by James N. Galloway and others, published April 2003 in Volume 53, Number 4 of Bioscience, pages 341-356**
2. Emerging National Research Needs for Agricultural Air Quality by V.P. Aneja and others, published in Eos, Transactions, American Geophysical Union, Volume 87, Number 3, January 2006, pages 25-29*
3. Use of Monte Carlo Analysis to Characterize Nitrogen Fluxes in Agro Ecosystems by Shelie A. Miller and others, published in Environmental Science and Technology, Volume 40, Number 7, 2006, pages 2239-2332**
4. Nitrogen and Marine Eutrophication, by Hans W. Paerl and Michael F. Piehler, to be published in Nitrogen in the Marine Environment, 2d edition, edited by M. Mulholland and D. Capone, Academic Press.**
5. Atmospheric Deposition of Nitrogen: Implications for Nutrient Over-enrichment of Coastal Waters, by Hans W. Paerl and others, published in Estuaries, Volume 25, Number 4b, pages 677-693, August 2002**
6. A briefing paper on Ethanol Production and Fertilizer Use prepared for The Fertilizer Institute, May 2006, and forwarded by William Herz.

Chair's emailed approval of minutes, March 8, 2007

* not available electronically, copy in FACA file

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