

**PEER REVIEW REPORT
FOR
WHITE PAPER: PERSPECTIVE ON
CREEPING BENTGRASS (*Agrostis stolonifera* L.)**

**USDA Animal and Plant Health Inspection Service
Biotechnology Regulatory Services
Riverdale, MD
June, 2006**

Report of Peer Reviewer 1

Does this White Paper accurately and objectively assess current scientific knowledge on *Agrostis stolonifera*?

Yes, subject to minor editorial changes.

Scope and Depth: The White Paper provides an extensive and in depth review of *A. stolonifera* biology and ecology. The paper in particular offers an in depth review of the literature of genetics and hybridization of *A. stolonifera*. I do not believe any significant references were omitted. Tables 1 and 2 are of particular importance because data are summarized and easily compared. The only weakness of the paper is the lack of discussion of creeping bentgrass in agronomic systems.

Currency: The document reflects current scientific thinking on the subject. It appears that the literature cited is thorough and up-to-date. Obviously, there are always more references but the author has been diligent in referencing current and important literature.

Clarity and Focus: There is no stated purpose for this White Paper. I would suggest that a section be added as to why this paper was prepared. There are sections that need to be edited for clarity. Perhaps using a number system for references would make the paper more readable. The references become distracting and often are the majority of the text.

Accuracy: The information is correct and accurately characterizes the content of references cited. Few conclusions or summary statements are made nor are significant areas of scientific uncertainty identified.

Objectivity: This White Paper is unbiased, fair and objective. The author provided the facts from references with little added interpretation of the results.

Report of Peer Reviewer 2

Whitepaper Review USDA-APHIS BRS

In my opinion, the manuscript entitled “White Paper: Perspective on Creeping Bentgrass (*Agrostis stolonifera* L.) is an accurate and objective assessment of the current scientific knowledge regarding the biology, ecology, genetics, and taxonomic status of creeping bentgrass (*Agrostis stolonifera* L.).

I base my opinion upon my personal knowledge of the species and the thoroughness and breadth of the literature review contained in the White Paper itself. This White Paper reviewed cited references from scientific journals, books, proceedings, theses and dissertations, Agricultural Extension bulletins, trade journal articles and web sites that have been published, or are otherwise available in the public domain, within the USA and abroad; and, also contain the most recent to the most relevant older literature.

Moreover, this White Paper synthesizes the relevant scientific conclusions in a very concise and interpretable manner. For example, the taxonomic complexities of creeping bentgrass are daunting, even for experts, and yet this White Paper compiles and explains the taxonomic relationships among *Agrostis* species, and the problems therein, in a very understandable fashion.

In addition, I found this White Paper to be aseptically clean of opinion or conclusion of any proposed hypothesis. For example, when describing the low levels of fertility among interspecific F1 hybrids (based on a potential of 1,800 seeds per inflorescence), the possibility was noted that such F1’s may be long-lived through vegetative propagation. However, the reader is left to infer for themselves whether or not this longevity would appreciably increase the “low level” of fertility over time. I view this absence of position as a problem only for any future publication of this White Paper in a scientific journal.

Lastly, I highly recommend that this manuscript be shared with other Federal government agencies with regulatory responsibilities, for example the US Patent and Trademark Office, as a demonstration of the extensive information resources available for utilization in such activities as “prior art” searches. In all seriousness, such agencies desperately need to be informed as to the extent of available data base resources and instructed in accessing the diversity of such global information.

Report of Peer Reviewer 3

White Paper on *Agrostis stolonifera*

Before beginning my comments, I should tell you that I provided a draft version to the author of [deleted]. [Author] commented that he was impressed by the thoroughness of the review and the fact that MacBryde did not gloss over the complexities of the genus, nor the amount that we do not know.

- **Scope & Depth** – Does the document adequately review the body of scientific knowledge on the subject of *A. stolonifera* biology and ecology? Are any significant references omitted?

The white paper provides a very thorough review of what is known about *Agrostis stolonifera*, and what is not known. I would prefer that what is not known to be emphasized because it is the unknown that leads to unforeseen problems. For instance, on p. 11 mentions that golf greens are sometimes cut vertically to reduce thatch. There is no statement, because there are no data, on whether the resulting fragments disperse into the surrounding area where they are more likely to flower.

- **Currency** – Does the document reflect current scientific thinking on the subject? Are references cited that are superseded by more recent literature?

My phrasing would be that it reflects current scientific knowledge. It is well written. It is my impression that the guidelines did not ask for a summary of scientific *thought*, just as the guidelines for reviewers are very clearly constrained. If by thought you mean factual conclusions, yes, they are reflected.

- **Clarity and Focus** – Is the purpose of the document clear? Are any sections vague or ambiguous?

The purpose is clear from the accompanying materials. The content of the document is well-written and, in general, clear. I am not sure what “them” in the last sentence refers to; otherwise I had not problem with understanding the content.

- **Accuracy** – Is any information in the document factually incorrect? Does the document accurately characterize the content of references cited? Are conclusions and summary statements drawn in the document scientifically justified? Does the document clearly identify significant areas of scientific uncertainty on the subject?

I am not aware of any factual errors in the document. The statements made seem to reflect accurately the content of the references cited. There are almost no conclusions drawn; the summary statements appear justified. Re areas of uncertainty, see under scope and depth.

- **Objectivity** – Does the document present the body of scientific knowledge on this subject in a fair, objective manner? Are references selectively cited or discussed in such a way as to introduce bias into the document? Are judgments the author makes regarding scientific uncertainty reasonable?

I would describe the document as painfully objective. I see no evidence of selective citation or discussion. The author is non-judgmental.

Report of Peer Reviewer 4

Reviewer Report

White paper: Perspective of Creeping Bentgrass, *Agrostis stolonifera* L

The individual components of the instruction to reviewers are delineated below. I have suggested a couple of areas where I believe additional information should be included prior to accepting this document.

There for I select (2) Yes, but only after revisions have been made to address specific weaknesses.

Scope and Depth – Does the document adequately review the body of scientific knowledge on the subject of *A. stolonifera* biology and ecology? Are any significant references omitted?

The underlying importance of the species is evident in the varied environments the various member of the genus have adapted to. The complexity of the genomic relationships between species further indicates the wide spread distribution of members of the genus. The overview, distribution and conservation of this genus is exhaustive however a simple search of the literature would suggest there remains additional species and or sub-species not mentioned in this otherwise exhaustive treatment.

A couple of additional species were reference on the following web site. Not other information was available other than what was presented as listed.

<http://www.funet.fi/pub/sci/bio/life/plants/magnoliophyta/magnoliophytina/liliopsida/poaceae/agrostis/index.html#clavata>

Agrostis pourretii Willd.

+ Kalpearölli

Agrostis laxiflora R. Br.

+ Hoikka rölli

Agrostis bottnica Murb.

Agrostis perennae Lindb. fil.

Agrostis laxiflora ; [SK], 68

Confusion remains in the referencing and naming of species with little clarity as to their distinctness. This document spends more time is making reference to previous citations (accurate or not) rather than deciphering the relationships.

Currency –

No real issues on currency of such information as the citations span the scope of evolution to present day knowledge especially in relation to seeded species.

Clarity and Focus –

The document hopefully as indicated in the instructions will be one of several supporting science based pieces used in assessing the biology and ecology of Creeping Bentgrass. This white paper is very vague on the purpose (other than to create a white paper) for its existence. As written this document is interesting, informative and generally poorly written, other than to delineate a rather extensive data base (references)

Accuracy –

The accuracy is not in question assuming we accept all referenced materials as being accurate. There appears to be no new or novel information provided in this accumulation of information.

Objectivity –

If on the other hand a statement were being made such as the following: "Understanding the Biology and ecology of *A. stolonifera* L. (creeping bentgrass) as an untransformed plant is essential to understanding the impact of an herbicide resistant transformed creeping bentgrass.", then possibly this document would have more merit.

The novelty of this scientific assessment is dealing with a perennial plant whereas all previous uses of this recognized technology has dealt with annual plants. It appears to be controversial mainly from an exclusivity and marketing stand point and is definitely precedent setting as an important technology as molecular manipulations appears to be readily available to most breeding and enhancement programs but could be restrictive in its use where perennial cropping systems are involved.

Further:

A major point of concern in hybridization between In discussing the creeping bentgrasses it would appear very little attention was given to the early collection of vegetative creeping bents. These were the primary grasses used from the early 30's until the release of Penncross as the first improved seeded grass available in the U. S. Seaside was recognized as a landrace variety from the western coast of Oregon and released in 1936 but was noted more for its excellent salt tolerance than an improved or superior developed cultivar. A total of 52 vegetative cultivars were originally collected and assembled at the USDA/USGA field facility (now the site of the Pentagon). A number of these grasses were used until as recently as 2000 but were generally limited in their area of distribution due primarily to the limitations imposed on movement and advancement of vegetative plant materials. As subtle as this information may be, the future of creeping bentgrasses should and will include the use, once again of vegetative cultivars – due in part to the controversial issues around genetically modified plants which are prone to pollen dispersal.

Report of Peer Reviewer 5

Review of “White Paper: Perspective on Creeping Bentgrass, *Agrostis stolonifera* L.”

Scope & Depth

Does the document adequately review the body of scientific knowledge on the subject of A. stolonifera biology and ecology?

The review of conservation of *Agrostis* species is fairly cursory and focuses primarily on species listed as threatened or endangered. This species level approach is only a single scale at which conservation is important. While the species-level approach is important, it does not adequately reflect the severe degradation of native grasslands in North America.

For example, in almost every region of the United States, very little native grasslands remain intact due to conversion to agriculture and invasive species. Native *Agrostis* species are an important part of this community and invasive *Agrostis* species pose major threats to native grasslands and wetland communities. It is important to address the community level perspective on this topic. Some of these topics are covered under section 7, but should be at least pointed to in the conservation section..

Genetics is also a critical part of any assessment of conservation impacts. This is especially true for species that hybridize easily, as it the case with *A. stolonifera*. Probably one of the most difficult challenges is dealing with hybridization between native and exotic species (e.g. invasion of *Spartina anglica* on the west coast) or between exotic species (Ellstrand & Schierenbeck. 2000. PNAS). Some of these potential conservation issues are suggested by the text in section 6.8, but are not addressed specifically as conservation issues.

A comprehensive review of conservation issues should go beyond a survey of threatened and endangered species lists.

Are any significant references omitted?

Perhaps Whitson et al. (1996) – see below.

Currency

Does the document reflect current scientific thinking on the subject?

My qualm in this regard is that the impacts of this invasive species are not fully portrayed. This species is listed as invasive by the USDA:

<http://plants.usda.gov/java/profile?symbol=AGST2>

However, the citations that are used by USDA to make this classification are either not cited (Whitson et al 1996) or cited only for taxonomy (Stubbendieck et al. 1994). I don't have either of these references on hand, but it seems that they may have information on the role of this species as an invasive.

Stubbendieck, J., G.Y. Friisoe, & M.R. Bolick. 1994. Weeds of Nebraska and the Great Plains. Nebraska Department of Agriculture, Bureau of Plant Industry. Lincoln, Nebraska.. 589pp.

Whitson, T.D. (Ed.) et al.. 1996. Weeds of the West. Western Society of Weed Science in cooperation with Cooperative Extension Services, University of Wyoming. Laramie, Wyoming.. 630pp.

Are references cited that are superseded by more recent literature?

There seem to be few more recent references, and nothing that would supersede the current review.

Clarity and Focus

Is the purpose of the document clear?

Yes.

Are any sections vague or ambiguous?

The text was generally quite clear.

Accuracy

Is any information in the document factually incorrect?

Does the document accurately characterize the content of references cited?

It seems that the importance of *A. stolonifera* as an exotic species is not fully portrayed. For example, the review states that *A. stolonifera* is “the species is rarely aggressively invasive” based in part on Gremmen *et al.* (1998). However, the abstract of this paper states: “These communities show a reduction of 50% in the mean number of native plant species per sample plot, although more macroinvertebrate and more mite species were found where *A. stolonifera* was dominant. The invasion by *A. stolonifera* does not seem to pose an immediate threat to the survival of any of the native species on the island, but the changes induced in the drainage line communities significantly reduce the value of the island both from a conservation viewpoint and as a natural laboratory for fundamental ecological research.” This sounds like a fairly major impact on the local ecosystem.

Are conclusions and summary statements drawn in the document scientifically justified?

See comments on the importance as an invasive species noted above.

Does the document clearly identify significant areas of scientific uncertainty on the subject?

Yes, except for the unknown risks of hybridization with native species in its invasive range.

Objectivity

Does the document present the body of scientific knowledge on this subject in a fair, objective manner?

Generally yes.

Are references selectively cited or discussed in such a way as to introduce bias into the document?

Not intentionally. I note a few points of interpretation above, but I have no reason to think that these are intentional.

Are judgments the author makes regarding scientific uncertainty reasonable?
Except for my concerns about addressing the importance of this species from a conservation standpoint as noted above.

Report of Peer Reviewer 6

TO: APHIS Peer Review Manager

Reviewer Report

**USDA-APHIS Peer Review of
“White Paper: Perspective on Creeping Bentgrass (*Agrostis stolonifera* L.)”**

- **Scope & Depth – Does the document adequately review the body of scientific knowledge on the subject of *A. stolonifera* biology and ecology? Are any significant references omitted?** The document covers the taxonomic and biological/ecological literature in a well organized fashion and presents a great deal of background detail that will be useful for making decisions on the future of the genetically engineered organism. The range of topics covered is relevant to the biology of the species, and covers this to the depth of knowledge of life history traits for the species *Agrostis stolonifera* and closely related species of concern. This said, I would add that the species has not been the focus of detailed study regarding its rate of increase in individuals or range as an invasive species in North America. Regarding fungal resistance and reproductive capacity of the particular strain selected for genetic modification, nothing is mentioned. In other words I would emphasize that there is a lot we do not know about this species.
- **Currency – Does the document reflect current scientific thinking on the subject? Are references cited that are superseded by more recent literature?** To the best of my knowledge the literature is current for all aspects of taxonomy, ecology, and genetic modification covered.
- **Clarity and Focus – Is the purpose of the document clear? Are any sections vague or ambiguous?** Yes the purpose is clear. The document reads well, the points are relevant to the decisions that need to be made. No sections were vague or ambiguous.
- **Accuracy – Is any information in the document factually incorrect? Does the document accurately characterize the content of references cited? Are conclusions and summary statements drawn in the document scientifically justified? Does the document clearly identify significant areas of scientific uncertainty on the subject?** To the best of my knowledge the information is factually correct. The document accurately characterizes the content of the references cited. The conclusions and summary statements drawn in the document appear to be scientifically justified. The document does clearly highlight areas of scientific uncertainty on the subject.
- **Objectivity – Does the document present the body of scientific knowledge on this subject in a fair, objective manner? Are references selectively cited or discussed in such a way as to introduce bias into the document? Are judgments the author makes regarding scientific uncertainty reasonable?** The document does present the scientific knowledge on the subject in a fair and objective manner. The

references cited and discussed introduce no apparent bias into the document. The judgments of the author makes regarding scientific uncertainty are reasonable.

Does this White Paper accurately and objectively assess current scientific knowledge on *Agrostis stolonifera*?

Please select one of the following responses:

- (1) Yes, subject to minor editorial changes (if any).**
- (2) Yes, but only after revisions have been made to address specific weaknesses.**
- (3) No, this White Paper has significant shortcomings in its assessment of current scientific knowledge on *Agrostis stolonifera*.**

1) Yes: To the best of my knowledge this White Paper accurately and objectively assesses current scientific knowledge on the taxonomy, biology, and ecology of *Agrostis stolonifera*. My only request for change would be to provide some descriptive and diagnostic detail for the species. As there are no keys to the complex of introduced *Agrostis* species in the US, particularly for the set of cultivated species, *A. gigantea*, *A. stolonifera*, *A. capillaris*, *A. castellana*, it would be useful for this document to have a key to these species and or table with the diagnostic characteristics. At a minimum a list references wherein one may find effective keys to the set of these species in European or other accounts would be helpful. This would assist reviewers and interested parties in identifying the plants in their regions. This would be valuable, as acknowledged in the white paper, because the taxonomy of the species has been historically significantly fouled up in the taxonomic literature in North America, and *A. castellana* has only recently become widely accepted as a species. Thus, one does not know which sources one can trust as providing current, accurate taxonomic descriptions and keys, or correctly identified illustrations or photos.

As most of the genetically modified plants released into the environment are food crop species, that by their “crop” nature have limited ability to disperse and establish on their own, and this particular organism differs from those crops in that the species is already known to be able to disperse and establish widely on its own, it would be appropriate to be able to monitor the distribution and of this particular genetically modified organism. There is a paucity of relevant information regarding tools and models to use in tracking this kind of organism, or its introduced gene for herbicide resistance. This reflects a lack of scientific studies in this realm, and is not a criticism of the white paper. It would be useful to cite relevant studies in crop species such as *Zea mays* with BT genes in them and tools and models used in following that, especially in light of the flaws seen in one or more studies intended to document dispersal of the BT toxin gene. Also, hybridization among close relatives is not the only way genetic material may escape (see: Bergthorsson. U. et al. 2003. Widespread horizontal transfer of mitochondrial genes in

flowering plants. Nature 424: 197-201. Bergthorsson, U. et al. 2004. Massive horizontal transfer of mitochondrial genes from diverse land plants donors to the basal angiosperm *Amborella*. Proc. Natl. Acad. Sci. U.S.A. 101: 17747-17752. Won, H. & S. S. Renner. 2003. Horizontal gene transfer from flowering plants to *Gnetum*. Proc. Natl. Acad. Sci. U.S.A. 100: 10824-10829.)

Additional References that may be usefull regarding natural history traits of *Agrostis stolonifera*:

Jones, M. D. and L. C. Newell. 1946. Pollination cycles and pollen dispersal in relation to grass improvments. Univ. Nebraska Agric. Exper. Station. Res. Bull. 148.

Salisbury, E. J. 1942. The reproductive capacity of plants, studies in quatitative biology. G. Bell and Sons, London.

Report of Peer Reviewer 7

Reviewer Report to: Peer Review Manager

Regarding: White paper: Perspectives on creeping bentgrass, *Agrostis stolonifera* L. USDA/APHIS/BRS (B. MacBryde, ver. 12/12/2005)

Prepared by: Anonymous, February 7, 2006

Answering: "Does this White Paper accurately and objectively assess current scientific knowledge of *Agrostis stolonifera*?"

Response: (2) Yes, but only after revisions have been made to address specific weaknesses.

Supporting detail

The White Paper thoroughly fulfills most of the criteria in the instructions (objectivity, currency, scope, and depth), especially in taxonomy and cytology. There are specific weaknesses in not including a statement of purpose as suggested in the review instructions, and in not addressing scientific uncertainty about native status and weediness and their definitions, and in not providing an adequate quantitative understanding of ecology and competitive mechanisms. The latter gap could reduce objectivity.

The taxonomy of *Agrostis* has been confused by the use of scientific names in the trade and by agronomists, and the White Paper does a fine job of explaining the species relationships, which is one foundation for other questions that may later be asked. Much of the White Paper merely heaps large numbers of citations to support a minor point, without justifying their inclusion, and ignores the pertinence of those cited papers to major points of ecology and competitive mechanisms.

While the first two weaknesses (no statement of purpose and uncertainty in concept of native status and weediness) can be corrected easily, the third weakness (quantitative understanding and ecology) may be difficult to correct, yet a failure to correct it may lead to biased interpretations.

1. Statement of purpose. The review instructions ask, "Is the purpose of the document clear?"

No, the White Paper document states no purpose, goal, or objective.

This is minor, and can be corrected. The cover document that was attached with the White Paper, but not a part of it, lists in the first paragraph these purposes: to summarize the biology and ecology of creeping bentgrass; to support the APHIS preliminary risk assessment of a genetically engineered strain of creeping bentgrass tolerant to the herbicide glyphosate; and to inform the decision to

prepare an environmental impact statement under the National Environmental Policy Act to assess potential impacts of granting the petition.

Therefore, if these are the purposes of the White Paper document, these can be imported to satisfy the need to make clear the purpose of the document.

2. Scientific uncertainty. The review instructions ask, "Does the document clearly identify significant areas of scientific uncertainty on the subject?"

No, despite pointing out by question marks in Table 1 and Figure 1, the uncertainty of cytotaxonomy, native status, and the occurrence of interspecific hybrids, there are significant areas of uncertainty that should be mentioned.

There is not a clear definition of native status, or the distinction between naturalized or introduced, nor is there any qualification of the inadequate evidence of early colonial history or native status of plant species based at best on inference from early writers. For example, *A. capillaris* is said to have been "introduced to New England early for pasture — it is mentioned in 1747 (Odland 1930) and likely was present a century earlier (cf. Cronon 1983; Sauer 1942)." Checking Sauer (1942), there is no mention of *Agrostis* spp., even though Carl Sauer mentioned the scientific names for other species. What Sauer did say was, "In the second half of the seventeenth century, English grasses began to make a noticeable improvement in pastures and meadows." What should be mentioned is that early English writers in North America gave very little attention to grass species, so the antiquity and identity of grass species in the 1600s and perhaps much later is speculative and uncertain.

There is not a clear definition of what is a weed, the terminology associated with weediness is inadequate and is based on multiple authors, and thus it is uncertain what is the weediness of creeping bentgrass and its relatives. For example, the areas where creeping bentgrass can establish are described as "relatively open or bare" and "somewhat dense," while introgressed backcrosses can be "notable aspects of some vegetation." These vague words increase scientific uncertainty. Some reference to attempts to define and predict weediness, and the difficulty of finding a universal understanding, would be helpful.

The foregoing areas of scientific uncertainty can be satisfied by providing definitions, by removing vague adverbs, and by stating that certain areas are uncertain.

3. Objectivity, quantitative relationships, and ecology. The review instructions ask, "Does the document present the body of scientific knowledge on this subject in a fair, objective manner?"

No, while the document presents taxonomic and cytological data in great detail, it inadequately presents other kinds of data, such as quantitative data, and is weak in the areas of ecology and the competitive interrelationships between creeping bentgrass and other species.

As one example, there is passing reference in a few places, most notably in 6.7, to a study by Wipff and Fricker (2001), which is said to pertain to pollen dispersal of creeping bentgrass and potential for fertilization and hybridization with other species.

In fact, the Wipff and Fricker study, while not dealing with the potential for hybridization with other species, directly observed in creeping bentgrass the attenuation of the rate of intraspecific gene flow with distance, which is very significant biologically and ecologically and should be given more detailed quantitative treatment in the context that it was intended, to make it more clear what the study learned and what is the degree of uncertainty.

The White Paper states that in the Wipff and Fricker (2001) study, the pollen traveled up to 4,296 ft, which was estimated, said the White Paper, "by calculation". In fact, in that particular experiment involving 1998 data from the NE transect, the pollen only traveled 268 feet, and the report of 4,296 ft was based on the authors' extending the calculated exponential decay curve beyond the realm of observation, to the distance that transgenic pollen introgression would be attenuated to 0.02%, which was an arbitrary point of estimate.

Wipff and Fricker did not estimate "by calculation" how far pollen traveled, but they estimated "by calculation" how far 0.02% transgenic pollen introgression would extend. Yet there is no mention of the 0.02% in the White Paper.

When an exponential decay equation estimates how far transgenic pollen introgression extends (recognizing the perils of estimating beyond the range of observation) the correct answer is "infinity". An exponential decay equation allows for estimating gene flow 10, 100, or even 1000 km from the origin. Although the estimates would be vanishingly small, they would still be larger than zero, as readily as there would be a non-zero estimate available for 4,296 ft from the origin.

The solution is for the implausibility of infinite pollen travel is to report exponential decay equations as fully as possible, as they were intended, along with appropriate estimates of uncertainty, even if a nonparametric estimate of risk has to be constructed from the data, and even if the exponential decay equations have to be reconstructed from the published figures.

Another solution to find meaningful and plausible information from an exponential decay equation with infinite tails is to multiply the rate of gene flow by the area affected, to find an aggregate gene flow.

If only the furthest absolute limit of known gene flow is reported, then that will necessarily understate the potential for gene flow, and if only an estimate of the absolute limit of known gene flow is reported, then that will overstate the potential for gene flow. Both results are biased, and both result from inadequately reporting quantitative rate data as it was intended to be used.

As another example of referencing good quantitative data, and then not doing anything useful with it, is the study of Lush (1990). This paper is cited as one of nearly 40 references supporting the fact that creeping bentgrass is normally seeded rather than propagated vegetatively. It can be easily established that creeping bentgrass is normally seeded, and it does not require nearly forty references to prove that.

But the point of the Lush (1990) study is that turfgrass species vary in biomass and tiller density, which can be used to predict visual assessment, wear, and possibly other biological and functional characteristics. Creeping bentgrass has the highest tiller density of any turf species, and that fact may be helpful when considering the potential of biological invasion and contamination of mixtures.

There are other kinds of quantitative data that might be available, and would be helpful to know, on the biology and ecology of bentgrass, for example, (a) What is the area and economic value of bentgrass grown in the landscape and on what portion of the world is it grown? (b) What is the percentage composition of bentgrass in natural and human affected ecosystems and does creeping bentgrass sometimes occur as a monoculture? (c) What is the percentage mention of bentgrass as a weed in various weed floras, compared with the percentage of its not being mentioned? (d) What other species (e.g., *Poa annua*) does creeping bentgrass occur with in the landscape, either as an intended mixture or as a contaminant, and what is the experience in cultural and herbicide management of such mixtures?