Review of the U.S. Department of Agriculture's Animal and Plan Health Inspection Service Response to Petitions to Reclassify the Light Brown Apple Moth as a Non-Actionable Pest: A Letter Report

Committee for the Review of the U.S. Department of Agricultureâ€™s Animal and Plan Health and Inspection Service Response to Petitions to Reclassify the Light Brown Apple Moth as a Non-Actionable Pest; National Research Council

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A Letter Report

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Board on Agriculture and Natural Resources

Division on Earth and Life Studies

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COMMITTEE FOR THE REVIEW OF THE U.S. DEPARTMENT OF AGRICULTURE'S ANIMAL AND PLANT HEALTH INSPECTION SERVICE RESPONSE TO PETITIONS TO RECLASSIFY THE LIGHT BROWN APPLE MOTH AS A NON-ACTIONABLE PEST

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This report has been reviewed in draft form by persons chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Research Council Report Review Committee. The purpose of the independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards of objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We thank the following for their review of the report:

Greg Baker, South Australian Research and Development Institute, Adelaide
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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of the report was overseen by Drs. Harley W. Moon, Iowa State University (emeritus) and Fred L. Gould, North Carolina State University. Appointed by the National Academy of Sciences, they were responsible for making certain that an independent examination of the report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of the report rests entirely with the author committee and the institution.

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August 31, 2009

Dr. David Kaplan
Assistant Deputy Administrator
Director, Emergency & Domestic Programs
USDA/APHIS/PPQ
4700 River Road
Riverdale, MD 20737

Dear Dr. Kaplan,

In February 2009, representatives of the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) approached the National Research Council's Board on Agriculture and Natural Resources (BANR) to ask for an objective technical evaluation of the service's response to two petitions to change the classification of the light brown apple moth (LBAM) from a quarantine-significant pest to a non-actionable/non-reportable pest. BANR assembled a committee of 10 members and charged it with evaluating the scientific basis of policy and regulatory decisions made by APHIS with respect to LBAM and the quality of evidence used by the agency in reaching its decisions. The committee was to determine whether APHIS satisfactorily addressed the specific arguments raised in the petitions for reclassification and whether its analysis of the arguments was balanced, thorough, and clearly articulated (see Appendix A for the committee's statement of task).

The members of the committee are pleased to provide this letter report containing their findings. The report represents the consensus of the committee (see Appendix B for committee member biographies). Material for review included the two petitions, the APHIS response (hereafter referred to as the Response), and ancillary Web-based materials. On July 9, 2009, the committee conferred by telephone and decided that additional information from APHIS was needed to permit evaluation of the Response; such information was provided by the agency on July 22, 2009. The committee met on the following 2 days in Washington, DC, at which time it put additional questions to APHIS. APHIS responded to further inquiries regarding the publication status of LBAM regulations in the *Federal Register* during the next week. The committee deliberated over the new information and the report in a conference call on July 30.

The format of this report, a brief document prepared over a short time, is well suited to the task at hand in view of the urgency perceived by the agency in addressing the regulatory status of a pest species newly discovered in California that is of economic importance elsewhere in its range. First reported in 2006, the moth has been found in 17 California counties; APHIS classified LBAM as a high-risk pest of quarantine significance and in fall 2007 initiated an eradication program in cooperation with the California Department of Food and Agriculture. The two petitions were filed in accordance with Chapter 18 of the USDA *Emergency Programs Manual* (Floyd et al., 2002), which details criteria for termination of an emergency eradication program.

In response to its statement of task, the committee found that APHIS did not “fully consider and address the specific arguments” and did not “conduct a thorough and balanced analysis” supporting the conclusions in its Response. Full consideration would have included a more detailed economic analysis and a more complete response to the argument against eradication. Overall, the committee found that the APHIS Response would greatly benefit from the use of more robust science to support its position. In responding to the petitions, APHIS would be well served by articulating the justification for its actions to the public clearly, and the Response should be revised accordingly. In addition, the LBAM regulations should be published for comment in the *Federal Register*.

Sincerely,

May Berenbaum, *Chair*
Committee for the Review of U.S. Department of Agriculture's Animal and Plant Health Inspection Service Response to Petitions to Reclassify the Light Brown Apple Moth as a Non-Actionable Pest

BACKGROUND

The light brown apple moth (LBAM) is a tortricid moth that is indigenous to southeastern Australia, where it feeds as a leafroller on some crops and a wide variety of ornamental plants and weeds. In the most comprehensive review of its ecology in that region, Geier and Briese (1981) describe LBAM as "neither ubiquitous nor long established as a pest of crops" but note that it can be damaging to seedling plants in nurseries, can spoil the appearance of ornamental plants, and can be injurious to deciduous-tree fruit, citrus, and grapes. They note further that the biology of LBAM is more variable than that of many similar insects and suggest that climate has a strong influence on both its distribution and its abundance. Climate can influence LBAM directly through effects on demographic performance and indirectly through the availability of food plants and the effects on natural enemies.

LBAM invaded New Zealand, England, Hawaii, New Caledonia, and Western Australia before it was discovered in California in 2006. Outside Australia, there have been reports of at least some degree of economic significance of LBAM as a pest of apple, pear, cane fruit, and grapes in New Zealand (Wearing et al., 1991) and as a pest of cherries in England (Fountain and Cross, 2007). Since its confirmation in California in 2007, LBAM has been classified by the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) as an actionable quarantine-significant pest, and APHIS has exercised its authority to implement a program of quarantine restrictions and eradication.

GENERAL ASSESSMENT OF APHIS RESPONSE

The secretary of agriculture received two petitions (one from the Pesticide Action Network North America and one from three private citizens) to reclassify LBAM as a non-actionable pest. LBAM is now classified as a quarantine-significant pest by APHIS and as a Class A pest by the California Department of Food and Agriculture (CDFA). In view of these classifications, LBAM is subject to quarantine and eradication efforts by both APHIS and CDFA. The petitioners requested that LBAM be reclassified as a non-actionable/non-reportable pest (APHIS) or a Class C pest (CDFA) on the basis of the argument that it is not an economically important pest and can be controlled by other means, including integrated pest management.[1]

Early in the review process, the committee experienced confusion about important regulatory terms and their ramifications for pest management at state and federal levels. Many terms and phrases used in the Response are unclear and undefined, particularly with respect to quarantine and actionable status. APHIS appears to be using the terminology of the International Plant Protection Convention (IPPC), the Plant Protection Act (PPA), and Executive Order 13112,

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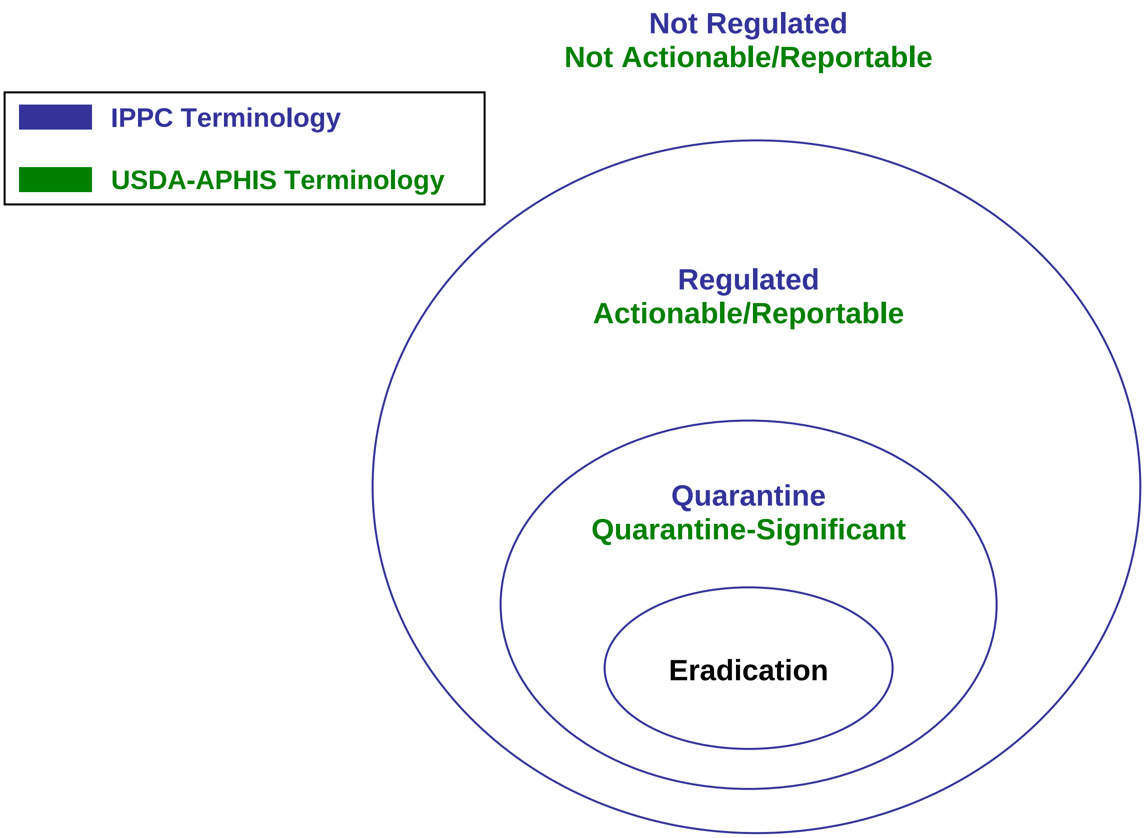
[1]Integrated pest management (IPM) is a long-standing science-based decision-making process that identifies and reduces risks posed by pests and pest-management–related strategies. It coordinates the use of pest biology, environmental information, and available technology to prevent unacceptable magnitudes of pest damage by the most economical means while posing the lowest possible risk to people, property, resources, and the environment. IPM provides an effective strategy for managing pests in all arenas from developed residential and public areas to wild lands (National Information System of the Regional IPM Centers, 2004).

and the petitioners apply terminology used by CDFA (Class A, B, C, and so on). The committee posed various questions to APHIS about its classification system for plant pests and how it is related to CDFA's system. Figure 1 represents the committee's best understanding of the relationships among the terms used by APHIS in these documents with respect to pests. The figure is purely descriptive; it does not represent any sort of recommendation or criticism by the committee regarding the relationship between these categories.

Figure 1: Committee's understanding of the relationships between categories defined by IPPC and APHIS terminology[2]



[2] This figure is intended to be descriptive. Any criterion implied by the figure is the committee's interpretation of existing terminology, not a recommendation or a criticism. The petitions included terms used by CDFA; however, the Response from APHIS does not. Therefore, the committee has chosen not to represent CDFA terminology in this figure.

The Response and associated decision to maintain LBAM as a quarantine-significant pest rely heavily on the definitions of *exotic pest* and *quarantine pest*. As defined by the IPPC (2008, 2009), a quarantine pest is "a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled".[3] Similarly, according to Executive Order 13112, an invasive species is any species that is not native to an ecosystem and "whose introduction does or is likely to cause economic or environmental harm or harm to human health". The definitions establish a series of questions around which APHIS organized the Response:

- Is LBAM native to the United States?
- Is LBAM widely distributed in the United States?
- Is LBAM a pest of potential economic importance to the United States?
- Is LBAM likely to cause environmental harm?

The IPPC and Executive Order 13112 provide no quantitative basis for determining what constitutes economic importance or what is economically significant. The secretary of agriculture has broad authority under the PPA with regard to establishing the magnitude of potential economic or environmental damage needed to trigger a regulatory response and significant discretion with regard to what action to take against any plant pest.

Given the qualitative, rather than quantitative, nature of the biological and economic criteria for determining a pest is quarantine-significant/actionable, the committee's general assessment was that the Response met the minimal requirements to support the contentions that LBAM is not native to the United States, has not yet reached the limits of its potential distribution in the United States, and may cause some level of economic harm (although projections of potential environmental impacts are less well founded). Thus, APHIS was within its authority in determining that LBAM is of "potential economic importance" and in continuing to classify it as quarantine-significant/actionable.

However, the committee found that the Response did not accurately portray the *most likely* future geographic distribution of LBAM in the United States or the *most likely* magnitude of economic harm. In not clarifying the intended purpose or specifying the underlying uncertainties of its analysis, the Response is ambiguous in depicting the consequences of LBAM establishment in the United States. Moreover, the Response does not adequately address the regulatory ramifications of retaining the quarantine-significant designation.

The petitions focused heavily on the infeasibility of eradication. APHIS did not address eradication, inasmuch as this issue is not relevant to determine quarantine status. APHIS's decision was justifiable in the context of stated policies and practices; but in adopting its strategy, APHIS has missed an important opportunity to explain and justify its course of action, that is, why it believes eradication is the best option for LBAM or what alternative strategies are available. It is the committee's understanding that while the PPA confers broad discretion, it does not obviate the need for rigorous science in arriving at and communicating the basis of decisions regarding pest status classification and actions taken to mitigate the problem.

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[3] "Controlled" may mean subject to quarantine (i.e., restricted movement), including but not limited to elimination of the pest through eradication.

Finding 1: *Under the IPPC, there are criteria for defining quarantine pest, but they are qualitative, rather than quantitative, biological, and economic criteria. Given the definitions of these criteria, APHIS justified its decision within its broad regulatory discretion, meeting the minimal standard, but has not communicated its justification in a scientifically rigorous way or with sufficient clarity.*

Recommendation 1: APHIS should define terms related to pest status explicitly and clearly, perhaps in an appendix. Independently of the Response, it should consider the development of guidelines to quantify when damage can objectively be considered of "economic importance".

LBAM AS AN INVASIVE SPECIES

To maintain the classification of LBAM as a quarantine-significant pest, APHIS presented in its Response an analysis of the history of LBAM as an invasive species, its status as a recent invader in California, and its predicted potential geographic distribution across the United States. Such assessments are often difficult to make in the absence of complete information, and the analysis presented in the Response is less than robust in several respects.

Prediction of Potential Geographic Distribution in the United States

The analysis presented in Figure 1 of the Response purports to describe the probability of LBAM establishment in the conterminous 48 states and is the basis of the economic analyses. The model (NAPPFAST) used to generate this map is not well documented with regard to assumptions and justifications. In addition, the operational definition of *establishment* as the ability of LBAM to complete at least three generations per year and not be exposed to temperatures below -16°C is inconsistent with the ecological definition of *establishment*. From an ecological perspective, establishment occurs when a species maintains a population through local reproduction without relying on immigration and irrespective of the number of generations completed annually (Davis, 2009). Degree-day models are useful for predicting the number of generations that ectothermic organisms can complete in an area, but they do not reflect the capacity of an organism to survive during periods of temperature or moisture extremes. Temperatures below the developmental threshold (about 7.5°C) but above -16°C may cause substantial mortality if they are maintained for sufficient duration (Gutierrez et al., unpublished, see Response VI. Literature Consulted). In addition, excessive heat is a major constraint on the distribution of LBAM (Danthanarayana, 1975; Danthanarayana et al., 1995), but it is not incorporated in the predictive model. Environments with high mean annual rainfall (over 1200 m) or annual mean low relative humidity (less than 66%) or high relative humidity (over 78%) have also been reported to be less suitable for LBAM population development (Danthanarayana et al., 1995). Inclusion of the effects of environmental extremes would probably limit the predicted potential distribution of LBAM substantially.

The interpretation of the model output as the probability of establishment (Response, p. 5) is technically incorrect. The map describes the number of years (or proportion of years) during the period 1999–2008 in which the APHIS operational definition of *establishment* was met (Fowler et al., 2009). However, ecologically, establishment assumes that a pest has arrived in adequate numbers, located suitable hosts, found suitable mates, avoided local antagonists, and survived environmental stresses.

The relationship between number of generations and crop damage is unclear. For example, Terauds (1977) notes that under the cooler climate conditions of Tasmania, it is the first of two LBAM generations per year that is responsible for most damage to apples in the region. In addition, although the predicted geographic distribution (Response, Figure 1) is based (according to Fowler et al., 2009) on 10 x 10-km grids, in implementing the predicted distribution for economic analyses the model establishes that only a single 10 x 10-km grid needs to be flagged as suitable for LBAM establishment for an entire county to be considered at risk (Response, Table 1). That practice can greatly expand the expected areas at risk from LBAM. For example, 44% of Washington counties are considered at risk (Response, Table 1), whereas the area of the state considered suitable for LBAM establishment (Response, Figure 1) is considerably smaller.

The modeling approach would have been better served by using a more robust model and providing enough information to permit judging of the quality of the simulation. For example, APHIS could have validated the robustness of the NAPPFAST model by comparing model predictions to the known distributions of LBAM in Australia, Hawaii, England, and New Zealand or by comparing the predicted distributions of LBAM in Australia with those generated by an alternative model, such as CLIMEX (Sutherst, 2000). In general, the Response does not address the suitability of alternative models (see, for example, Guisan and Thuiller, 2005; Marmion et al., 2009) that have been used to predict the distribution of invasive species. It is critical that this part of the analysis be robust; otherwise, any later economic analysis will be flawed. For example, the predicted distribution of LBAM in the Central Valley of California (because of its production of high-value crops) has an enormous influence on estimates of economic loss.

Invasion Status of LBAM

The genetic analysis (Response, p. 3), although unpublished and unavailable outside APHIS, points to multiple introductions in California over an unknown period of time. For such a high level of genetic diversity to result from a single introduction, as proposed by APHIS (Response, p. 5), seems less likely as it would have required the introduction of an exceptionally large number of LBAM from a genetically diverse source population. A single recent introduction is also less compelling in that the survey and trapping regimen used in California before 2007 was probably inadequate to determine the presence or absence of LBAM—a limitation not explicitly acknowledged in the Response. “Routine surveys” by federal and state agencies at ports and nurseries (Response, p. 5) were not aimed specifically at LBAM before 2005, and the likelihood that LBAM would have been correctly identified is low because of limitations on taxonomic oversight. Similarly, the evidence that “specific surveys in the area where LBAM currently exists from the late 1950s to the present did not find this species” (Response, p. 5) is based on trapping efforts conducted in specific locations in coastal California from 1960 onward that did not include either San Francisco or Santa Cruz, the two “hot spots” from which LBAM appears to be spreading (USDA-APHIS, 2009). Moreover, the reference provided to support this evidence, attributed to Rubinoff and Powell, was not prepared by them, is unpublished, and is not accurately cited (Powell, pers. comm.). Thus, sufficient information is not available to allow a rigorous assessment of the true age of the LBAM invasion in California.

Similarly, the statement (Response, p. 5–6) that the recent trapping data from infested areas show a progressively increasing population is misleading in that the limitations of the census methods are not discussed. The increase in mean moths per trap per month may partly reflect the increasing number of traps and the increasing geographic area of their placement, inasmuch as both can increase the probability of inclusion of localized high-density populations. Data derived from repeated trapping at the same locations with constant trapping efforts are more informative.

This section of the Response also includes imprecise citations of the published literature. For example, with respect to LBAM as an invasive species, the Response (p. 3) states that LBAM "has shown a tendency to readily surmount geographical and environmental barriers, establish itself quickly, and then expand its population in size and range in new habitats, all hallmarks of invasive species (Ehrlich, 1986; Mack et al., 2000; Richardson et al., 2000)." The sentence is imprecise and, as a result, its meaning may be misunderstood. The references are not supporting the statements about invasiveness and the threat of establishment of LBAM in particular; rather, the references refer to traits that are common to invasive species in general. The phrase "readily surmount… environmental barriers" could be misinterpreted to suggest that LBAM easily and routinely developed an ability to survive a broader range of environmental conditions (e.g., temperatures) in areas outside its native range. There is no evidence to support such a claim. Similarly, there is no evidence to suggest that previous LBAM invasions occurred readily or quickly. As noted in the Response, it is simply known that LBAM has invaded different geographical regions (New Zealand, Hawaii, New Caledonia, England) and that movement of LBAM in these countries was facilitated by human activity. A better approach might be to cite a previous National Research Council report on invasive species (NRC, 2002) that identified previous invasion success in other areas as one of the best predictors for invasiveness. Thus, it would be more accurate to replace the sentence cited above with "LBAM has arrived, established, and spread in areas outside its native range. For other exotic species, a history of successful invasion has proven to be a strong predictor of future invasion success (NRC, 2002)." Re-writing this paragraph would remove the problems in it associated with the imprecise language and improper citations.

Similarly, the paragraph (Response, p. 4) on adaptation of LBAM to new host plant species and the implication of associated genetic changes is not well founded and should be omitted. Most of the new host plant records from California (U.S. Department of Agriculture-MRP/APHIS, 2008), whose sources are not in the Response, almost certainly do not reflect a host shift through genetic adaptation but rather the fact that LBAM is exposed to an additional range of host plants in a new geographic region (North America) to which it is already preadapted by virtue of its polyphagous feeding habits. Whether the new records from California document suitable new host plants that fully support LBAM development and reproduction, however, remains unclear.

Finding 2: *The biological data presented in the Response to support the invasive nature of LBAM, its history in California, and its potential geographic distribution in the United States are problematic and in some cases not based on sound, rigorous science. In particular, the prediction of the potential geographic distribution of LBAM in the United States presented in Figure 1 of the Response, and all economic analyses based on it, are questionable and in need of reassessment with a more rigorous approach.*

Recommendation 2a: APHIS should clearly cite the source of all information in the Response, represent the sources accurately and fully, and make all cited sources available to the public. Additionally, APHIS should not rely on unpublished literature. If gray literature is used, it should be represented appropriately.

Recommendation 2b: With regard to Figure 1 in the Response, APHIS should consider more biologically reasonable and validated modeling approaches to predict potential geographic range.

IMPORTANT ECONOMIC FACTORS

Classification of a pest depends on its capacity to cause economic damage. In its Response, APHIS presented evidence of the potential to cause economic damage to agricultural production, trade, crops, nursery stock, and natural areas.

Impacts on Agricultural Production

The committee's understanding is that a key consideration for classifying a pest as actionable is that its presence has a significant potential economic impact. The committee has substantial concerns regarding the economic component of the Response. Its concerns are based primarily on the ambiguous foundation of the analysis for the predicted geographic distribution of LBAM and the inconsistent and sometimes incomprehensible analytic techniques used in the Response.

Economic analyses of the impacts of invasive species are often limited by a lack of information; it is clear that LBAM is not exceptional in this regard. However, the committee finds that in numerous places the results reported in the Response are not appropriately qualified. The Response does not address when a lack of information is problematic. For example, there is substantial uncertainty about the ability of LBAM to spread geographically, about its host range, and about the severity of damage that it can inflict on host plants. At a minimum, the economic analysis should discuss potential limitations and cautions; otherwise, its results imply an unwarranted degree of certainty.

The presence of LBAM is not sufficient to establish the existence of economically significant losses. Economically significant losses are a function of yield damage, market price, and cost increases. The Response would benefit by addressing each of these components in more detail.

The Response does not clearly document the basis of damage estimates. Two sources (Fowler et al., 2007, 2009) are cited for estimates of yield losses. The two sources have different yield-loss estimates, but they appear to be used interchangeably at some points in the Response. Field damage—the sum of control costs and yield loss—is said to vary between 0.08% and 1.4% (Response, p. 9, 16), but yield loss is described as 5% (Response, p. 17); the discrepancy is not addressed. The Response provides no sources to substantiate damage estimates. Elsewhere, the Response cites Fowler et al. (2009) as the source for details on the economic analysis, but Fowler et al. (2009) does not mention a 5% yield loss. The Fowler et al. (2007, 2009) documents actually use estimates of 1–2.3% for the most likely magnitude of crop damage. Thus, the committee could not determine conclusively the basis of the yield-loss estimates in the Response.

The set of crops on which estimates are based appears to shift throughout the Response without a clear explanation of the change. In extending the economic analysis in the Response from the four commodities considered by Fowler et al. (2009) to 35 commodities (Response, Table 3), the Response assumes a much smaller range of field losses, 0.08–1.4%, without documentation (Response, p. 9). Perhaps the difference is due to the much greater economic losses associated with a much broader commodity base, but the Response provides no explanation. The question of which crops are at risk appears to be based on expected host plant range (U.S. Department of Agriculture-MRP/APHIS, 2008), with the implicit assumption that any commodity that shares a genus with a recorded host plant is probably at risk. For example, almonds are among the most valuable commodities in California (Response, Table 3), but the committee found no supporting evidence in the Response that LBAM is likely to be a pest of almonds. Moreover, it is unclear whether some of the damage estimates are based in part on quarantine compliance costs; this would be inappropriate if domestic regulators rather than obligations to trading partners impose such costs.

The Response does not explain the goal of the economic analysis. The goal of earlier analyses by Fowler et al. (2007, 2009) was to give expected damage estimates for apple, grape, orange, and pear. It appears, however, that the goal of the current Response was to show the greatest damage that might occur in extreme (and presumably unlikely) trade-restriction scenarios (for example, the $9 billion in potential phytosanitary and trade-related losses). A more appropriate goal might be to contemplate a minimal justifiable geographic distribution and host range in view of the limited information that is available. The Economic Research Service study by Livingston et al. (2004) regarding the potential impacts of the entry of Asian soybean rust is an example of a study of an invasive problem that addresses uncertainties explicitly.

The committee believes that better use can be made of the existing information base despite its shortcomings. For example, loss estimates in the Response do not address the price effect of a decline in production quantity. Price increases as quantity decreases and could thus reduce economic losses for some crops. On the demand side, own-price demand elasticities[4] for a large number of crops are available through the Economic Research Service (http://www.ers.usda.gov/Data/Elasticities/) and could be used to inform the analysis. On the supply side, an increase in production cost due to LBAM could alter supply. One example of an analysis of an invasive-species problem that incorporates such considerations is that by Acquaye et al. (2005), which evaluated the economic effects of citrus canker in Florida. Another supply-side consideration not used in the Response is that growers may reallocate acreage among crops in response to the establishment of LBAM in their region, because of changes in costs or yields. Existing economic models of growers' crop-acreage allocation decisions could be modified to assess the potential economic impacts of LBAM (e.g., Tanaka et al., 2006). In addition to making better use of the existing information base, the committee wonders whether information generated since the identification of LBAM in California might be accessed and used to provide better insight into economic impacts.

[4]Own-price demand elasticity is a measure of the percentage change in the demanded quantity of a good caused by a percentage change in its price.

Impacts on Trading Partners

In general, the Response does not provide enough detail on how estimates of economic values and losses are calculated. In some instances, there are no citations to additional APHIS documents providing details to support the analysis in the Response, nor are the details provided in the Response itself. For example, Table 7 shows values for “selected commodities by HS-Codes”.[5] It is unclear whether the agency is listing total values for all products under a two-digit code or choosing particular crops and merely listing them by HS codes. If the former is the case, the total value of all those commodities may not be a meaningful basis for calculations. In the absence of explanation of which values are relevant for decision-making, it is not clear why what appears to be a worst-case estimate is presented. Various trade scenarios could also be presented. For example, APHIS could use the quarantine list or exemptions list as a basis for judging the impact of more narrowly defined trade restrictions, or it could focus on the same set of major host crops considered in Fowler et al. (2009) as a more probable basis for estimating potential trading losses (and this approach would be consistent with approaches taken in other parts of the document).

Moreover, data sources for economic calculations are not always transparent. Estimates per acre of nursery crops are extremely difficult to calculate. The Response reports cost calculations (p. 20) based on O’Brien (2008), an e-mail communication from an industry source that is not provided on the APHIS Web site. Whether the reported costs would be in addition to current pest-management costs is unclear in view of the heavy routine use of pesticides for nursery crops (information on pesticide use on nursery and floricultural crops is available through the National Agricultural Statistics Service (2007)). It is not clear how these numbers are related to LBAM quarantine status.

Environmental Impacts

The section on silviculture (Response, p. 17) implies that previous literature provides evidence that the potential for “environmental damage” to forest plantations is substantial. In reality, however, the cited references consider the damage to forests by LBAM to be minimal or do not specifically address it. Kay (1991) notes LBAM as one of several indistinguishable tortricid species that can be found in indigenous forests in Australia and New Zealand, where they are seldom accorded pest status. In eucalypt plantations in Australia, Collett and McBeath (2007) report finding three tortricid species and low-intensity damage by LBAM in only 1 of 3 years and finding that trees recovered fully. In New Zealand, Nuttall (1983) noted that LBAM was one of three tortricids that could be found in pine plantations and that the indigenous blacklegged leafroller was generally the most damaging. A more recent study of pine plantations

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[5]The Harmonized Commodity Description and Coding System (HS) is an internationally standardized system of names and numbers for classifying traded products; it is developed and maintained by the World Customs Organization. The first two digits of the coding system refer to chapters in the HS. The chapters highlighted in Table 7 of the Response are Chapter 6 (“Live Trees and Other Plants; Bulbs, Roots, and the Like; Cut Flowers and Ornamental Foliage”), Chapter 7 (“Edible Vegetables and Certain Roots and Tubers”), and Chapter 8 (“Edible Fruit and Nuts; Peel of Citrus Fruit or Melons”).

in New Zealand by Brockerhoff et al. (2002) estimates LBAM to be as abundant in pine forests as in orchards. However, the estimate is based entirely on counts of LBAM males collected with pheromone traps rather than on observation of larval feeding habits, and as the study authors acknowledge, the trapped moths may have come from other host plants in the landscape rather than pines. Thus, in contrast with the implications of the Response, the available literature does not provide compelling evidence that LBAM is an important pest of silviculture.

The host plant list compiled by USDA (2008) is used extensively to justify potential threats of LBAM to native plant species. The threat to endangered plant species appears to be based on the assumption that, inasmuch as LBAM is known to be a polyphagous feeder, a positive record for one plant species in a genus should lead to the interpretation that all members of the genus would be equally susceptible or good host plants. That assumption expands the potential environmental impacts on endangered plants dramatically (Response, Table 8). While the committee acknowledges that there is no alternative to this approach, it would clarify the Response substantially to state the underlying assumption in the text (Response, p. 18) that describes Table 8. In addition, the reference cited in Footnote 3 of Table 8 does not confirm host use, and if any such data do exist it would be helpful to add a column to the table to indicate which host plant species have been confirmed and whether the confirmation arises from an isolated record or from a series of repeated observations.

Finding 3: *Economic data—number of crops, yield impacts, native and endangered species, and trade implications—are not evaluated consistently; some estimates are probabilistic, others are point estimates. Many limitations and assumptions used to estimate environmental and economic impacts are neither explicitly acknowledged nor explained.*

Recommendation 3: APHIS should present economic estimates consistently where possible, use a range of scenarios with regard to policy and scientific uncertainties, and acknowledge uncertainties and limitations explicitly. Moreover, it is important to distinguish clearly between worst-case and likely scenarios and where possible to take market responses into account.

CLARITY OF ARTICULATION

Communication and Citation of Supporting Evidence

The committee encountered difficulties early on in evaluating the balance and comprehensiveness of the analysis because of an absence of clearly articulated definitions. For example, the committee asked how APHIS uses information regarding cost of control and eradication in designating a pest as actionable/reportable; the response to this inquiry stated that "if a quarantine significant pest is detected and there is an opportunity to eradicate it before it becomes established in the United States, APHIS . . . would consider eradication . . . provided that effective eradication tools are available." But the second sentence of the APHIS Response—"Establishment in the State was confirmed in March 2007"—renders the decision to begin an eradication program puzzling. The authors of the Response apparently use "establishment" synonymously with "discovery". This imprecise language may contribute to confusion in the context of the feasibility of eradication, a contentious point of the petitioners.

A communication issue arose with respect to discussions of scientific uncertainty. The predicted-establishment map (Response, p. 5) presents essentially the entire southern tier of the United States as an area with a “100 [%] probability of establishment”. The committee knows of few biological predictions that can be made with 100% certainty, and presentation of a risk analysis in these terms does not accurately reflect the inherent uncertainty associated with the process. Qualifying language is needed on scientific grounds; its absence undermines the credibility of the Response. Another communication issue in the Response is that literature is referred to without citations, for example, on p. 16, “The literature also suggests that natural control can be sporadic, and incapable of preventing economic losses.” Inadequately documented statements weaken the credibility and clarity of the Response and eliminate opportunities to provide the public with critical information.

In the Response, APHIS chose to focus entirely on the regulatory status of LBAM. Although recognizing that the petitioners also questioned the use of eradication as the current action strategy for LBAM in California, APHIS chose not to address this issue. The committee considers that choice to constitute a missed opportunity for APHIS to present its findings and to justify its actions to stakeholders and the general public. Eradication is one of several actions that can be taken in response to an invasive species and has been used successfully against some invasive insect pests. Myers et al. (2000) clearly articulate the criteria that are prerequisites for success; two of the most important are early detection to implement eradication before an invasive species becomes too widespread and establishment and maintenance of public support to provide the lead agency with a clear mandate for action. It is debatable whether APHIS has met either of those criteria with respect to the LBAM invasion, and APHIS may be well advised to reconsider the available alternatives.

Finding 4: *Use of scientifically imprecise terminology confuses the debate and undermines credibility.*

Recommendation 4: APHIS should use policy and science language with precision and should acknowledge and accommodate the multiple audiences targeted by the Response.

Approach to Public Input

APHIS took regulatory action to control the human-assisted spread of LBAM by issuing a federal order on May 2, 2007. The order established a federal quarantine and regulations for the interstate movement of various commodities from the quarantined area to prevent the human-assisted spread of LBAM. The order was amended on four occasions to add or delete various counties. APHIS has not published a proposed or final rule in the *Federal Register* for comment under the Administrative Procedure Act. Typically, in situations of this kind, such rule-making would take the form of an interim rule that would be effective on publication with an opportunity for public comment. APHIS would then respond to the comments and make changes to the rule on the basis of the comments received.

The public has not had the opportunity to comment formally on the LBAM regulations issued under the federal orders. In not publishing the regulations in the *Federal Register* for public comment, APHIS has not taken advantage of an important opportunity to explain and justify its position. If APHIS had engaged in rule-making soon after the initial federal order was issued, it most likely would have started a formal discussion of many of the issues and received the benefit of public comment concerning its regulations much earlier.

Finding 5: *APHIS has not taken advantage of the opportunity to explain and justify its actions and meet its obligations under the Administrative Procedure Act by publishing the LBAM regulations for comment in the* Federal Register.

Recommendation 5: APHIS should publish its LBAM regulations for comment in the *Federal Register*.

ADDITIONAL COMMENTS

APHIS is in the unenviable position of having to respond rapidly and appropriately to a newly discovered and extraordinarily polyphagous pest species on which the available data are sparse. Beyond the biological impacts, the agency acknowledges that "the greatest economic threat posed by LBAM is losses associated with trade restrictions on host plants and commodities in both international and interstate trade." Trade restrictions have been known to be imposed in ways that ignore basic biology; the recent trade restrictions on pork products in response to swine influenza are a case in point.[6]

The use of language regarding pest status in the two petitions suggests that the petitioners do not fully understand APHIS criteria for designating quarantine-significant status, and it is incumbent on the agency to clarify regulatory language and practices and to distinguish among these terms in the Response. In not addressing any other issue raised by the petitioners, APHIS misses an opportunity to share relevant information, explain its decisions, and reduce public concerns. Classification status (the stated subject of the petitions) is not synonymous with control procedures (a major focus of the petitions). In particular, the feasibility of eradication, only one of several control approaches, is a concern of the petitioners that will not be assuaged by the Response. Scientific information on the feasibility of eradication of invasive insects generally is available (Dahlsten and Garcia, 1989; Veitch and Clout, 2002), and addressing this matter in the Response or in a separate report should be seriously considered.

Finding 6: *Limiting the scope of the Response has not aided APHIS and may have exacerbated public concerns about the eradication effort.*

Recommendation 6: Independently of the Response to the petitions, APHIS would be well served by conducting a study, including scientific feasibility and cost–benefit analysis, of LBAM eradication and alternative control approaches.

Thus, in response to its statement of task, the committee found that APHIS did not "fully consider and address the specific arguments" and did not "conduct a thorough and balanced analysis" supporting the conclusions in its Response. Full consideration would have included a more detailed economic analysis and a more complete response to the argument against

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[6]See, for example, http://www.twnside.org.sg/title2/wto.info/2009/twninfo20090705.htm.

eradication. Overall, the committee found that the APHIS Response would greatly benefit from the use of more robust science to support its position. In responding to the petitions, APHIS would be well served by articulating the justification for its actions to the public clearly, and the Response should be revised accordingly. In addition, the LBAM regulations should be published for comment in the *Federal Register*.

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APPENDIX A

Review of U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) Response to Petitions to Reclassify the Light Brown Apple Moth as a Non-Actionable Pest

STATEMENT OF TASK

To evaluate the ability of policy and regulatory decisions to be supported by sound, scientific evidence and effectively communicated in a transparent fashion, an NRC committee will examine the scientific bases of two competing opinions about the classification of the Light Brown Apple Moth (LBAM) as an actionable pest, based on petitions from various parties in California to reclassify the pest, and on federal documents that justify and defend the rationale for the current pest classification. The committee will focus on the comprehensiveness and credibility of the federal justification in light of arguments to the contrary. The committee will prepare a letter report evaluating whether the justification:

- fully considers and addresses the specific arguments for reclassification raised in the petitions and their accompanying documentation; and

- clearly articulates a thorough and balanced analysis that justifies and adequately supports its conclusions in response to the petition.

APPENDIX B

Biographical Sketches of Committee Members

MAY R. BERENBAUM, *Chair,* is a member of the National Academy of Sciences and Professor and Department Head of the Department of Entomology at the University of Illinois at Urbana-Champaign. Dr. Berenbaum earned her Ph.D. in Ecology and Evolutionary Biology from Cornell University and has been a member of the Department of Entomology at the University of Illinois at Urbana-Champaign since 1980, chairing the department since 1992. Her research addresses the chemical mediation of interactions between plants and insects and encompasses multiple hierarchical levels, ranging from molecular mechanisms to community structure. In addition, she is concerned with the practical application of ecological principles to insect-plant interactions in an agricultural context. For this research, she has received many honors, including the Robert H. MacArthur Award from the Ecological Society of America, and is a fellow of the Entomological Society of America and the American Philosophical Society. Dr. Berenbaum currently serves on the editorial boards of several journals, including the Proceedings of the National Academy of Sciences, and is President of the American Institute of Biological Sciences. As a member of the National Academy of Sciences, she serves on the Division on Earth and Life Studies Committee and has chaired National Research Council boards and study committees, including the Board on Agriculture and Natural Resources, and the Committee on the Status of Pollinators.

THOMAS E. BUNDY is a former Deputy Assistant General Counsel in the Office of General Counsel at the U.S. Department of Agriculture (USDA). In his 31 years experience as an attorney for the USDA, he supervised legal work for the Animal and Plant Health Inspection Service (APHIS), including the control and eradication of plant and animal diseases and pests. He was instrumental in the drafting and passage of the Plant Protection Act and the Animal Health Protection Act, and is very knowledgeable concerning USDA's animal and plant quarantine authorities and their application, both domestically and internationally. He has instructed APHIS employees on how to implement and enforce those authorities. Since retiring from the Federal government in 2002, Mr. Bundy has consulted with various organizations, including the Pew Charitable Trust Initiative on Food and Biotechnology regarding USDA’s authority under the Plant Protection Act and the Animal Health Protection Act. Mr. Bundy received his J.D. from the University of Virginia School of Law.

SEAN B. CASH is a Faculty Associate in the Department of Consumer Science, University of Wisconsin–Madison, and an Associate Professor in the Department of Rural Economy at University of Alberta (Canada). His research focuses on the economics and policy of environmental protection, resource conservation, food, and health. Recent research areas include border enforcement for reducing invasive species risks, risk ranking in food safety issue, the impact of economic incentives on consumer health, and corporate incentives to participate in cooperative resource management schemes. He has provided expert input to Alberta's inter-agency taskforce on invasive species risk assessment tools. Dr. Cash serves on the executive committee of the food safety and nutrition section of the Agricultural and Applied Economics Association, and on the editorial board of the *Canadian Journal of Agricultural Economics*. He holds a Ph.D. and M.S. in Agricultural and Resource Economics from the University of California, Berkeley, as well as an M.A. in Economics from the University of Michigan and a B.A. in International Relations from the Johns Hopkins University.

RACHAEL E. GOODHUE is an Associate Professor in the Department of Agricultural and Resource Economics at the University of California, Davis. Dr. Goodhue's work has a strong public policy focus, and her research is concentrated in two areas: the industrial organization of agriculture, particularly agricultural contracts; and agri-environmental policy, particularly pesticide regulation and the economics of invasive species. Her interests include property rights and institutions governing natural resource use, including impacts of property rights design for pastoralist systems in sub-Saharan Africa, and negotiations over water rights and use in California and France. Dr. Goodhue has served on editorial boards including the Associate Editor, Agricultural Economic, 2007–2009; Editorial Council, Journal of Agricultural and Resource Economics, 2006; the American Journal of Agricultural Economics, Journal of Agricultural Economics, Agricultural Economics, and the Review of Industrial Organization. She is a member of Gamma Sigma Delta and Phi Beta Kappa. Dr. Goodhue holds a Ph.D. in Agricultural and Resource Economics from the University of California, Berkeley.

VINCENT P. JONES is a Professor in the Department of Entomology and head of the Insect Ecology and Behavior Laboratory, located at the Tree Fruit Research and Extension Center, Washington State University. His background and experience involve the use of various aspects of population biology, ecology, and insect behavior to improve integrated pest management (IPM) of insects and mites. Dr. Jones seeks to improve IPM programs by developing much of the basis of management systems (e.g., sampling/monitoring systems for key pests, phenology models, basic information on life history and population demography, dispersal). His current projects are focused on improving biological control in tree fruit orchards. Towards this end, Dr. Jones directs a recently funded Cooperative States Research Education and Extension Service (CSREES), U.S. Department of Agriculture Specialty Crops Research Initiative Grant with 9 others from California, Oregon and Washington. In addition to active research, Dr. Jones has developed an outreach program based on emerging knowledge on IPM for the WSU Decision Aid System that help growers and fieldmen optimize their pest management strategies. Dr. Jones is an accomplished scientist with over 92 refereed articles and book chapters. His professional service includes: Reviewer (1999–2005), President (2006), and President-Elect (2005) Western Orchard Pest and Disease Management Conference. He holds a Ph.D. in Entomology from the University of California at Riverside.

NICHOLAS J. MILLS is a Professor in the Department of Environmental Science, Policy and Management at the University of California, Berkeley. Dr. Mills' research focuses on biological control of insect pests and the ecology of insect parasitism and predation. He is currently working on a classical biological control program for the Light Brown Apple Moth in California.

The major emphases in his work involve addressing the determinants of success in classical biological control and the augmentation of natural enemy populations. His research interests include a variety of aspects of natural enemy biology, from behavior and evolutionary biology to population and community ecology through observational, experimental, and comparative analysis. Dr. Mills has been awarded the Division of Agriculture and Natural Resources Distinguished Service Award, Outstanding Faculty, 1997; and the College of Natural Resources Distinguished Teaching Award, 2002. Dr. Mills publishes peer-reviewed articles regularly with well over 100 articles and is highly cited. Dr. Mills holds a Ph.D. in Population Ecology from the University of East Anglia, UK.

L. JOE MOFFITT is a Professor in the Department of Resource Economics at the University of Massachusetts-Amherst. Professor Moffit's research is on the economics of crop protection with particular emphasis on new technology and biosecurity. He lectures on quantitative methods in resource economics, and is especially interested in applications of economics to biology-based crop protection and in applications of biology-based quantitative methods to economics and econometrics. He has written 25 extension reports and over 50 research publications. His service and outreach activities include advising agricultural agencies about the economics of crop protection programs and chairing the Herbert L. Forest Scholarship Committee. He is a member of the American Agricultural Economics Association, the American Economic Association, and the Northeastern Agricultural and Resource Economics Association. Dr. Moffitt has also served as a member on the NRC Committee on California Agricultural Research Priorities: Pierce's Disease. Dr. Moffitt received his Ph.D. in Agricultural and Resource Economics from the University of California, Berkeley.

JERRY A. POWELL is Director Emeritus of the Essig Museum of Entomology and Professor Emeritus of Entomology at the University of California-Berkeley. The principal theme of Dr. Powell's research has been to discover and correlate biological features with traditional morphological evidence in the development of biosystematic relationships of small moths, particularly tortricids. His research has served to develop comprehensive local inventories of the species, to provide means for estimating species' diversity in North Temperate Zone* Lepidoptera, and to analyze larval-host plant relationships of the Lepidoptera communities. Dr. Powell has published extensively on the biodiversity, evolution, and field behavior of Lepidoptera. He has also served as President of the Society of Systematic Zoology, the Pacific Coast Entomological Society, and of the Lepidopterists' Society. He received his Ph.D. in entomology from the University of California-Berkeley.

DANIEL S. SIMBERLOFF is the Nancy Gore Hunger Professor of Environmental Studies at the University of Tennessee and past president of the American Society of Naturalists. He received his A.B. from Harvard College in 1964 and his Ph.D. in biology from Harvard University in 1968. His 350 publications center on ecology, biogeography, evolution, and biometrics, and they often relate to the causes and consequences of species associating with one another in communities. Much of his research for the last 20 years has focused on conservation issues, such as reserve design, the consequences of fragmentation and habitat destruction, and the impacts and management of introduced species. His research projects involve insects, plants, birds, and mammals. He directs the University of Tennessee Institute for Biological Invasions. He was instrumental in formulating the presidential Executive Order 13112 on invasive species, and serves on the International Union for Conservation of Nature (IUCN) Invasive Species

Specialist Group and the IUCN Species Survival Commission. Dr. Simberloff is the recipient of numerous awards, including the Ecological Society of America's Eminent Ecologist Award. Among his many professional activities, he served as Associate Editor of the Annual Review of Ecology, Evolution, and Systematics (2001–present), and as a member of the National Science Board (2000–2006), the National Marine Fisheries Service Recovery Science Review Panel (2004–2006), the Editorial Board of BioScience (1994–present), and as Editor-in-Chief of Biological Invasions (2008–present). Dr. Simberloff has served on previous committees and was a member of the Board on Life Sciences.

ROBERT C. VENETTE is currently a Research Biologist with the USDA Forest Service, Northern Research Station and Adjunct Associate Professor in the Department of Entomology, University of Minnesota. He specializes in the areas of invasion biology and pest risk assessment. His research primarily focuses on the development and application of methods to predict the potential geographic and impact of nonnative organisms that are not known to occur in the United States or are present, but of limited distribution. He has studied insects, pathogens, and weeds. Species that he has studied include Mediterranean pine engraver (*Orthotomicus erosus*), the South American noctuid moth (*Copitarsia corruda*), the causal agent of sudden oak death (*Phytophthora ramorum*), reed canary grass (*Phalaris arundinacea*), and, recently, light brown apple moth (*Epiphyas postvittana*). His review of the statistical underpinnings of surveys for rare individuals was cited as a foundational document by the European Plant Protection Organization during the development of EPPO Standard PM 3/65(1) *Sampling of consignments for visual phytosanitary inspection*. Dr. Venette also helped to pioneer the development of a graduate curriculum on risk analysis for introduced species and genotypes at the University of Minnesota. The effort was sponsored primarily by the National Science Foundation program for Integrative Graduate Education and Research Traineeships. Dr. Venette has produced several “mini” pest risk assessments that have been used by state and federal agencies to inform strategic decisions about surveys for exotic pest species. Dr. Venette received his PhD in 1997 in Ecology from the University of California, Davis.