Raszka Shelley

From: Gallagher Chuck
Sent: Monday, March 30, 2015 7:28 AM
To: Raszka Shelley
Subject: FW: HB 2183
Attachments: Quinn et al 2014 GCBB Regulatory uncertainty.pdf

From: lauren.quinn@gmail.com [mailto:lauren.quinn@gmail.com] **On Behalf Of** Lauren Quinn
Sent: Sunday, March 29, 2015 10:38 AM
To: Gallagher Chuck
Subject: HB 2183

Dear Mr. Gallagher,

Please accept this email as written testimony in support of HB 2183, which requires a larger bond for growing Arundo donax as a bioenergy crop in Oregon.

I am Ph.D. ecologist who studied invasive A. donax populations in California as the subject of my doctoral dissertation. While the climate in Oregon differs from that in southern California, where invasive A. donax dominates many thousands of riparian acres, there is no guarantee that a) the climate will not become more favorable for A. donax in Oregon's future, and b) that A. donax will not establish even now in Oregon's waterways. This has not been studied enough in Oregon, and is, therefore, unpredictable and risky. And if A. donax does escape and establish in wetland areas, it will be extremely difficult to remove. Arundo spreads primarily through fragmentation of its large rhizomes during flood events, so once it has established in a river system, it is very likely to persist and spread.

Oregon's current regulations relating to A. donax production do not provide for an adequate bond measure. $100/acre is an absolutely unrealistic bond for eradication of A. donax outside of cultivation (or even within cultivated fields). It has been estimated that Arundo removal and restoration can cost $25,000/acre (see http://www.cal-ipc.org/ip/research/arundo/Arundo%20Distribution%20and%20Impact%20Report_Cal-IPC_March%202011.pdf). I urge you to adopt HB 2183, increase the bond requirement, and provide for situations in which A. donax plantations are abandoned. For further recommendations for regulatory language relating to bioenergy plantations, please see the attached article.

Thank you for your consideration.

Lauren Quinn

Lauren D. Quinn, Ph.D.
Technical Editor, Illinois Sustainable Technology Center
Research Associate, Department of Crop Sciences
University of Illinois
Urbana, IL 61801
708-753-3709
ldquinn@illinois.edu
http://laurendquinn.weebly.com/

GLOBAL CHANGE BIOLOGY
BIOENERGY

GCB Bioenergy (2014), doi: 10.1111/gcbb.12216

COMMENTARY

Resolving regulatory uncertainty: legislative language for potentially invasive bioenergy feedstocks

LAUREN D. QUINN[1], ELISE C. SCOTT[1], A. BRYAN ENDRES[1,2], JACOB N. BARNEY[3], THOMAS B. VOIGT[1,4] and JAMES MCCUBBINS[1]

[1]*Energy Biosciences Institute, University of Illinois, Urbana, IL 61801, USA,* [2]*Department of Agricultural and Consumer Economics, University of Illinois, Urbana, IL 61801, USA,* [3]*Department of Plant Pathology, Physiology and Weed Science, Virginia Tech, Blacksburg, VA 24061, USA,* [4]*Department of Crop Sciences, University of Illinois, Urbana, IL 61801, USA*

Abstract

Concerns about invasions by novel bioenergy feedstocks are valid, given the parallels between the traits of energy crops and those of many common invasive plants. As the bioenergy industry is poised to introduce nonnative bioenergy crops to large acreages in the United States under state and federal mandates, it is important to consider these concerns – and not simply in an academic sense. Instead, the prevention of invasions should be codified in statutes and regulations pertaining to bioenergy production on both the state and federal level. Unfortunately, this is not occurring regularly or consistently at this time. The few existing regulations that do consider invasiveness in bioenergy systems suffer from vague terminology that could have major economic, environmental, and legal consequences. Here, we discuss existing regulatory challenges and provide solutions to address invasion potential of bioenergy crops. We provide model definitions and provisions to be included in revised or new state and federal regulations, including an invasion risk assessment process, a permit and bond system for high-risk crops, and a risk mitigation provision for all novel crops. Our proposal provides a consistent and transparent system that will allow the industry to move forward with minimal risk of invasion by novel feedstocks.

Keywords: biofuel, bond, feedstock, invasive, nonnative, policy, regulation

Received 19 March 2014; accepted 2 June 2014

Introduction

The industry that has sprung up in response to the Energy Independence and Security Act of 2007 seeks to provide products to meet mandates for second generation or cellulosic fuels. Policies that regulate traditional feedstocks derived from corn, soy, sugarcane, and other food crops are not necessarily adequate to address issues arising from dedicated cellulosic feedstocks. Land use conversion, originally thought by some to be a minor issue when considering nonfood crops (Berndes *et al.*, 2003), does require consideration as farmers convert conservation land to production acreage for perennial grasses and other feedstocks (Secchi & Babcock, 2007). Another issue not typically associated with traditional food-based feedstocks is that of invasiveness, or the potential for crops to escape cultivation through seed or vegetative propagule dispersal, and subsequently establish where they are not wanted. Yet the similarities between the traits of an ideal feedstock (Heaton *et al.*, 2004) and those of invasive plant taxa have been noted by scientists and policy analysts alike (Raghu *et al.*, 2006; ISAC, 2009). Many scientists and environmental groups have expressed concern about the potential for invasion by cellulosic feedstocks (GISP, 2007; Cousens, 2008; ISAC, 2009; Davis *et al.*, 2010; Low *et al.*, 2011; Glaser & Glick, 2012), with some earning high-risk scores in some locations via weed risk assessments (Barney & Ditomaso, 2008; Buddenhagen *et al.*, 2009; Gordon *et al.*, 2011, 2012). Biological invasions must be avoided, as they can be extremely costly (Leung *et al.*, 2002; Pimentel *et al.*, 2005), and can lead to further invasions (Simberloff & Von Holle, 1999) or bring about irreversible ecosystem impacts (Simberloff, 1996). The federal and state policies that regulate this new industry should encourage its growth, while meeting greenhouse gas emissions targets and other minimum sustainability standards, including invasion mitigation (IUCN, 2009; Endres, 2011a; RSB, 2013), all without imposing other harms on the environment.

Although dedicated energy crops may be associated with a number of novel environmental issues not linked to first generation feedstocks (e.g. invasiveness), existing

Correspondence: Lauren D. Quinn, tel. 708 753 3709, fax 217 244 3637, e-mail: ldquinn@illinois.edu

regulations are based on food crop production systems and largely ignore these issues or provide inadequate language to support programs or practices that could prevent and/or mitigate them. Absent or vague language related to environmental impacts, especially related to invasion potential, could result in (i) opportunity for accidental spread of invasive plants outside of cultivation, as well as attendant effort and costs associated with their cleanup; and/or (ii) delayed maturation of the bioeconomy (Endres *et al*., 2012) as governments make *ad hoc* determinations of invasion potential and/or add *ex post* requirements for bonds, containment, and management. Although industry may oppose invasion assessments and mitigation requirements as burdensome, the bioeconomy is arguably disrupted to a greater extent by unclear and indiscriminately applied rules (Engau & Hoffmann, 2009), as well as lengthy public comment and deliberation time. Thus, we recommend the inclusion of consistent and transparent invasion prevention and mitigation language in all new and revised legislation related to bioenergy products at the state and federal level.

Bioenergy proponents and others have asked why their industry, relative to traditional agriculture and other energy sources, is being singled out for such intense scrutiny and so many onerous requirements (Endres, 2011b). The answer is that we have learned from past mistakes [e.g. the purposeful introduction by the US Soil Conservation Service of kudzu (*Pueraria montana*) to prevent erosion in the 1930s and 1940s (Langeland *et al*., 2008)], and now have the rare opportunity to apply these lessons to an emerging industry that is set to introduce a number of novel crops with varying degrees of invasion potential. The other major industries introducing novel plants, agriculture, and ornamental horticulture (Mack & Erneberg, 2002), have been established in this country for more than a century, before we had a firm understanding of the impacts of weedy and invasive species. As a result, we must play catch-up to control problem plants introduced before laws regulating these industries were enacted – and these regulations (e.g. the Plant Protection Act and related state noxious weeds laws) still do not adequately prevent introduction of plants with invasion potential outside of cultivation (Mccubbins *et al*., 2013; Quinn *et al*., 2013). And unfortunately, existing voluntary invasion prevention programs in the horticulture industry have very low adoption rates primarily due to poor outreach efforts (Burt *et al*., 2007). Therefore, there is concern that similar voluntary programs in the bioenergy industry could fail to 'catch on'.

The Precautionary Principle urges us to prevent potential harm to society and natural capital in the face of uncertainty such as the potential impacts of nonnative bioenergy crops, but has inherent limitations and has a history of over-application (CAST, 2013). Science and pragmatism must work hand-in-hand and be built into proactive regulations to prevent future environmental harm. We argue that transparent regulations relating to invasiveness will help, not hinder, the industry, and enhance economic and natural capital sustainability. We also acknowledge that our suggestions represent just one way to meet the goal of invasion prevention by this industry and others. Alternative legal reforms have been developed that would apply to all plant industries, including overhauling the methods used to create state and federal noxious weeds lists and creating negligence liability pathways for those that knowingly commercialize high-risk crops or ornamental plants (Mccubbins *et al*., 2013; Quinn *et al*., 2013). Although we endorse these reforms for the bioenergy industry, they will not be reviewed extensively here. Instead, we focus on novel language to be incorporated in legislation and regulations relating to bioenergy at the state or federal levels. However, we recognize that this language could be modified for use in legislation and regulations pertaining to other plant industries.

Absence of language relating to invasiveness hurts the bioeconomy

The US Environmental Protection Agency (EPA), directed by Congress to implement programs mandating a steep rise in bioethanol production from second-generation feedstocks under the Energy Independence and Security Act and its Renewable Fuel Standard (RFS) (40 C.F.R. §§ 80.1100-80.1167), also strongly influences market dynamics on the supply side through its acceptance or denial of proposed fuel pathways. These pathways are judged by their lifecycle greenhouse gas (GHG) emissions profiles, and EPA's approval requires no formal assessment of other environmental impacts including potential escape and invasion by nonnative feedstocks (40 C.F.R. §§ 1426). In the past, and for more traditional bioenergy feedstocks such as corn starch and stover, this process has been relatively straightforward. But companies recently petitioning EPA for evaluation of the nonnative bioenergy feedstocks *Arundo donax* (giant reed), *Camelina sativa* (Camelina), *Pennisetum purpureum* (napier grass), and *Saccharum spp*. (energycane) met with unanticipated delays in approval. These delays were due, in part, to public comments relating to the potential for these crops to escape and invade outside cultivation. Public comments to EPA invoked Executive Order 13112, which states that federal agencies must not support activities that promote invasive species. These comments, and others relating to GHG calculations, prompted the EPA to rescind its initial

approval of the four feedstocks, and to make new, *ad hoc* determinations after considering invasion concerns. All four species were eventually approved because they met legal standards for favorable lifecycle GHG emissions profiles. EPA's final ruling, however, includes provisions requiring producers of *A. donax* and *P. purpureum* to prove nonsignificant risk of spread by the feedstocks, or to complete a risk mitigation plan that includes development of best management practices and third-party evaluation of spread (EPA, 2013). The *ad hoc* consideration of invasiveness resulted in an 18 + month delay for approval of *A. donax* and *P. purpureum*, and cost the petitioners millions of dollars in revenue losses and consultants' fees (D. Richardson, personal communications). We argue that similar impacts to industry could be avoided if Congress and state legislatures responded to this ongoing concern by passing laws that empower agencies to incorporate language relating to invasion assessment, prevention, and mitigation in bioenergy regulations. Thus, industry could refer to transparent criteria and definitions prior to making investments in questionable products, saving both time and money.

Regulating a method of invasion avoidance into a revised RFS would not be unprecedented. EPA could look to Maryland's Renewable Portfolio Standard (RPS) [Md. PUBLIC UTILITIES Code Ann. § 7-701 (2013)], which exempts 'invasive exotic plant species' from qualifying as approved biomass feedstocks. Similarly, the US Department of Agriculture (USDA)'s Biomass Crop Assistance Program (BCAP) prohibits subsidies for growing noxious and potentially noxious weeds or invasive species as biomass crops – as defined by state and federal noxious weeds laws and results of weed risk assessment tools (113th Congress, 2014). The federal noxious weeds law, included in the Plant Protection Act of 2000, and similar state noxious weeds laws were created to protect agriculture, the environment, and the economy of the United States and states from plant pests and noxious weeds. These laws do not specifically discuss bioenergy crops, but their language, discussed below, can serve as a useful model for improvements to state and federal bioenergy regulations.

In codifying standards for risk mitigation plans in future rulings, EPA could look to Oregon, Mississippi, and Florida, which limit establishment of nonnative feedstock plantations through the use of permits, surety bonds, and mitigation provisions. Oregon and Florida enacted these laws after environmental groups protested the planting of nonnative feedstocks (*A. donax*, in both states) by energy/biomass companies (D. Hilburn, personal communications). States can act as laboratories of public policy, informing possibilities for other states and at the federal level, and we propose that other states and EPA adopt language from these state codes in drafting new or revised bioenergy legislation.

Vague terminology

While state initiatives to address invasiveness concerns in the bioenergy industry are laudable and, in principle, can serve as models for federal regulations, the absence or vagueness of invasion terminology renders these laws less effective. For example, Maryland's RPS exempts 'exotic invasive plant species,' but does not define the terms exotic or invasive or cite to its agricultural code, which does include a definition of invasive pertaining to nonnative species causing 'severe harm' or 'substantial negative impact' within the state (Md. Agriculture Code Ann. § 9.5-101). Mississippi's law (Miss. Code Ann. § 69-25-10) controls planting of nonnative plants that 'may become invasive or constitute a nuisance', and applies retroactively to existing plantings of nonnative species grown for purposes of fuel production or 'purposes other than agriculture' (undefined). However, the criteria used to determine whether a plant could become invasive are not defined. Florida's law (F.S.A. § 581.083) defines invasive plants as 'naturalized plants that disrupt naturally occurring native plant communities,' without further defining 'naturalized' or 'disrupt.' Florida's law also references its definition of noxious weeds, which includes 'any living stage … of a parasitic or other plant … which may be a serious agricultural threat in Florida or have a negative impact on the plant species protected under [Florida's threatened and endangered plant statute].' No definition of 'serious' or 'negative impact' is given. Oregon's law [OAR 603-052-(1206-1250)] only applies to one species, *A. donax*, so does not necessarily require a definition of invasive for assessment of other feedstocks, but thus lacks generality and broad applicability.

The language in the BCAP regulations, the only known federal bioenergy regulations acknowledging the invasiveness issue, clearly states that invasive, potentially invasive, and noxious species are exempt from BCAP support. However, BCAP does not provide a self-contained definition of invasive and is therefore not an ideal model for future regulations. Instead, it refers to the definition of noxious provided in the Plant Protection Act. The PPA defines noxious weeds as those 'plants or plant products that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment.' State noxious weeds laws generally borrow language directly from the federal law in defining noxious, or are very similar. If these laws were

applied as broadly as their definitions, they could be a powerful deterrent against introduction of potentially invasive plants. Unfortunately, in a recent analysis, it was found that fewer than 20% of important invaders, on average, were represented on state noxious weeds lists (Quinn *et al.*, 2013).

Unfortunately, it is no simple matter to define 'invasive' or 'harm' in the context of invasive species. The subsidiary concepts of 'native' and 'non-native' also suffer from definitional uncertainty (Warren, 2007). Even invasive plant ecologists have failed to use these terms consistently (Colautti & Richardson, 2009). Davis (2009) argues that this equivocality can create problems, in that 'invasion ecologists, managers, and *policy makers* [emphasis added] can easily end up miscommunicating with one another by not realizing that they mean different things while using the same words, or the same thing with different words.' There have been efforts to standardize the terms, including a definition of invasion applied to introduced plants that have been transported by humans across a major geographical barrier to establish reproductive populations that then give rise to additional reproductive populations in distant locations (e.g. over 100 m away over a 50 year time scale or less) (Richardson *et al.*, 2000). Another definition relies on dispersal distance and includes a metric of impact on the recipient habitat or community (Davis & Thompson, 2000). Other definitions or conceptual constructs relating to what is meant by 'invasion' have been proposed in the intervening years, but debate continues in the ecological community (Colautti & Richardson, 2009). Our intention here is not to solve a decades-long debate among ecologists, but instead to provide practical definitions that can be consistently applied by regulators and easily interpreted by stakeholders to avoid introduction of plants that could cause harm to the environment. Note that we do not single out 'non-native' plants, not only because 'native' plants can be invasive (Simberloff, 2008) but also because it is a matter of interpretation whether improved or novel genotypes of 'native' species would still qualify as 'native' and, therefore, 'safe'. Our definitions seek to eliminate that potential confusion.

Without inclusion of transparent and well defined invasiveness clauses in the rulemaking process, environmental groups, bioenergy industry representatives, legislators, and regulators will continue to work at cross purposes, further slowing the progress of this nascent industry. In the environmentalists' worst-case scenario, in the absence of clearly defined and enforced standards, bioenergy companies will be allowed to establish plantations whenever and wherever they desire, potentially causing severe and widespread environmental havoc. In the industry representative's worst-case scenario, environmental lobbyists will demand examination of their every move, delaying or even halting their operations and business potential. Although the opportunity for public commentary is a crucial component of democratic lawmaking (Criddle, 2011), ideally, laws will be specific and holistic enough to avoid major argument and attendant delays with each proposed feedstock. Inclusion of invasiveness language in relation to bioenergy regulations not only has the opportunity to prevent industrial delays but also, equally or more importantly, could prevent invasion of harmful feedstocks outside cultivation. Clearly, it is more effective and economical to prevent invasions than to control them *ex post facto*, particularly after major population expansion (Lodge *et al.*, 2006; Rice, 2008). Federal and state agencies have an opportunity to take preventive action *now*, before inadvertent widespread introduction of invasive feedstocks by the nascent bioenergy industry.

We suggest the following definitions, based on fundamental biological, ecological, and management principles, for inclusion in revised or novel bioenergy regulations (for which model language, using these definitions, will be supplied in the next section). Literature references included in these definitions and in the provisions below are not intended to remain in actual regulations, but are provided as justification for the concepts and methods provided herein. Also, where agencies are referenced in square brackets, the appropriate state or federal agency names or jurisdictional levels could be inserted.

Definitions

1. *Escape*: movement of seeds, plant parts, or whole plants beyond the boundaries of cultivation. Can occur through natural processes (e.g. wind dispersal of seeds) or through human-mediated means (e.g. seed spillage *en route* to the field).
2. *Establishment*: Survival and reproduction of an escaped plant (see definition 1) through one or more generations.
3. *Impact*: a quantifiable change in ecosystem metric(s) (e.g. species richness, litter quantity). A net negative ecological impact would constitute harm. Requires assessment before and after establishment by an invader, or comparison with reference site absent the invader (see Barney *et al.*, 2013 for suggested methods).
4. *Invasive*: a population exhibiting a net *negative* impact (or 'harm') to the target ecosystem.
5. *Noxious*: plants regulated under state and/or federal noxious weeds law.
6. *Risk Mitigation Plan*: a formal plan that will include the practices used by developers, farmers, transporters,

and refinery personnel to prevent unintentional dispersal of plant material (e.g. seeds, vegetative fragments, and whole plants) away from cultivation areas, roads, and loading areas, and also to include specific control/eradication strategies to be used in the event of escape or abandonment. These practices should be specific to the crop in question and based on current knowledge of the biology and ecology of the crop. Example invasion-avoidance management practices are available (e.g. Barney, 2012).

7. *Weed Risk Assessment (WRA)*: a science-based protocol requiring an assessor to answer a number of questions about the biology and ecology of a plant taxon before arriving at a determination of high (invasion) risk, low risk, or requiring further evaluation. An example is the recently developed WRA tool by USDA's Plant Protection and Quarantine (PPQ) program (Koop *et al*., 2012).
8. *White list*: a list of species prescreened by WRA that received low (invasion) risk determinations for a given region. [Agency] must make results of WRAs available for all screened taxa. Those with low-risk determinations (on the current white list) are allowed to be planted *in the region for which they were assessed* without further evaluation (unless the evaluation was done more than 10 years prior, *or unless novel germplasm lines of white-listed species are developed and intended for introduction*) (see Quinn *et al*., In Press for details).

How could regulations be improved?

Elements of the state and federal regulations discussed above will be useful in reforming or creating federal and other state laws that could prevent invasion by bioenergy feedstocks. First, the very recognition of the potential for invasiveness in regulations is a worthy starting point. Second, although most of the above state and federal regulations fail or vaguely define what constitutes invasive or harm, some laws (e.g. in FL and MS) designate expert authorities – scientists at cooperating state universities – to make those determinations. For example, the experts at the University of Florida include a dedicated staff that runs weed risk assessments under investigation at UF or in response to agency requests (Ifas Invasive Plant Working Group, 2013). While we argue that it is important to define these terms in legal documents, it is equally important to rely on science and expert opinion in deciding questionable outcomes, and to do so expeditiously.

A model regulation relating to bioenergy at the state or federal level would include intuitive and science-based definitions of key terms including 'invasive' and 'impact' or 'harm' (see above), would ban taxa already regulated as noxious (see Quinn *et al*., 2013 and Mccubbins *et al*., 2013 for suggested improvements to invasive plant regulations), allow for a method to determine which plants *may become* invasive, and would designate authorities within state or federal agencies or institutions to make final determinations if a company should petition for allowance of a potentially invasive crop. In addition, these regulations would include language requiring growers and biofuel producers to follow guidelines to avoid escape of any nonnative feedstocks, should designate enforcement authorities, and consequences for failure to meet these requirements. We argue for requirement of such mitigation plans for both low- and high-risk feedstocks, to encourage at least a minimum level of vigilance and surveillance in acknowledgment that novel crops planted at large scales may behave unpredictably. There is precedent for the requirement of best management practices for low-risk feedstocks (in this case, sterile *Miscanthus* × *giganteus*) in USDA's current BCAP program. However, we allow for less stringent requirements for low-risk crops than high-risk ones.

We suggest the following specific language to be incorporated into revised or novel bioenergy regulations to provide a baseline framework that state or federal agencies could customize with their individual needs and concerns. The provisions in this model regulation are based on existing regulations in three states (FL, MS, and OR) and in two federal agencies or programs (EPA and USDA BCAP). The existing laws were generally reactionary, resulting from moves by industry actors to introduce potentially invasive taxa. We encourage state and federal legislatures (e.g. in a revised RFS) to empower agencies to include invasiveness language *proactively* in any statutes or regulations pertaining to bioenergy.

Provisions

1. Under [state or federal] noxious weeds regulations, no noxious weed shall be introduced for purposes of biomass production. However, because existing noxious weeds laws do not fully represent the taxa that impact nonagricultural habitats, it will be necessary to assess any novel germplasm not appearing on [state or federal] white lists for its potential invasiveness in that region through WRA, or if not enough data exist to complete a WRA, then by field testing for evidence of invasive characters (see Quinn *et al*., 2013 for suggested methods).
2. Parties involved in developing, growing, or commercializing bioenergy feedstocks (*hereafter, bioenergy stakeholders*) are advised to refer to the definition of invasive (this document) and [state or federal] 'white

lists' of low-risk feedstocks (e.g. Quinn *et al.*, In Press) to guide feedstock selection and motivate selective breeding for traits that may confer less risk of invasion.

3. If bioenergy stakeholders choose to test or commercialize feedstocks not on a [state- or federally] accepted white list in an area greater than 1 acre across testing locations, they will be required to complete a permitting process which will include a formal weed risk assessment (WRA) using existing data on publicly available WRA databases (e.g. PIER, 2013) or in scientific literature, or using the USDA PPQ WRA tool to be completed by [state or federal] Invasive Plant Councils (see Mccubbins *et al.*, 2013 and Quinn *et al.*, 2013), or relying on expert opinion of weed scientists or invasive plant ecologists at [state land grant university].

   (a) Permits will be granted *if*:

   (i) the plant in question is not found to be at high risk of invasion in the production region according to WRA results or field tests and/or it has been determined through deliberate testing by independent scientific bodies that the plant causes no net negative ecological impact in the region (e.g. using methods similar to those in Barney *et al.*, 2013), *and*

   (ii) bioenergy stakeholders submit a risk mitigation plan in accordance with accepted best practices to avoid invasion by bioenergy feedstocks (see Barney, 2012).

   (b) Permits for low-risk crops can be renewed annually without reapplication for up to 5 years, after which time risk mitigation records and implementation will be reviewed by [state or federal agency].

   (c) Permits may be granted for the testing or commercialization of high-risk feedstocks, as determined by WRA, field test results, or findings of negative ecological impact *if*:

   (i) a risk mitigation plan is submitted and approved, with the further requirement that stakeholders designate and pay for neutral third parties to perform annual (or more frequent) unannounced site inspections to ensure proper handling of plant material at all phases of production, and to inspect land surrounding production fields to determine whether feedstocks have escaped and established in the area; *and*

   (ii) a bond is paid prior to establishing the crop. The [state or federal agency], working with experts and consulting relevant literature, will determine the payment before approving a permit application. The bond amount will be set to pay for control and eradication of cultivated, abandoned, and/or escaped plants [to a specified distance away from the production area, set as appropriate to account for seed and/or vegetative dispersal of taxon or taxa under permit] upon a finding of invasiveness by [state or federal agency]; *and*

   (iii) Bioenergy stakeholders failing to properly carry out these steps acknowledge that they may be subject to negligence liability actions if high-risk plants escape and establish (e.g. see Mccubbins *et al.*, 2013). These permits can be renewed annually, pending review of risk mitigation records kept by growers and reports filed by third-party inspectors.

We argue that the suggested regulatory changes will ultimately benefit the bioenergy industry by reducing or eliminating reactionary responses by the public and regulatory bodies, and will create transparent expectations that can be agreed upon by all parties. In addition, as previously stated, the language we have drafted specifically for the bioenergy industry could be adapted to apply to other plant industries seeking to introduce novel taxa. We now have the opportunity to avoid past mistakes and protect environmental assets while allowing for safe industrial expansion, and we must act.

Acknowledgements

This study was funded by the Energy Biosciences Institute.

References

Barney JN (2012) Best management practices for bioenergy crops: reducing the invasion risk. Virginia Cooperative Extension, Publication PPWS-8P.

Barney JN, Ditomaso JM (2008) Nonnative species and bioenergy: are we cultivating the next invader? *BioScience*, **58**, 64–70.

Barney JN, Tekiela DR, Dollete ESJ, Tomasek BJ (2013) What is the 'real' impact of invasive plant species? *Frontiers in Ecology and the Environment*, **11**, 322–329.

Berndes G, Hoogwijk M, Van Den Broek R (2003) The contribution of biomass in the future global energy supply: a review of 17 studies. *Biomass and Bioenergy*, **25**, 1–28.

Buddenhagen CE, Chimera C, Clifford P (2009) Assessing biofuel crop invasiveness: a case study. *PLoS ONE*, **4**, e5261.

Burt JW, Muir AA, Piovia-Scott J, Veblen KE, Chang AL, Grossman JD, Weiskel HW (2007) Preventing horticultural introductions of invasive plants: potential efficacy of voluntary initiatives. *Biological Invasions*, **9**, 909–923.

CAST (2013) *Impact of the Precautionary Principle on Feeding Current and Future Generations*. Ames, IA. Available at: http://www.cast-science.org/file.cfm/media/products/digitalproducts/CAST_Issue_Paper_52_776B77B328854.pdf (accessed 24 June 2014), Council for Agricultural Science and Technology Issue Paper 52.

Colautti R, Richardson D (2009) Subjectivity and flexibility in invasion terminology: too much of a good thing? *Biological Invasions*, **11**, 1225–1229.

113th Congress (2014) Agricultural act of 2014. In: Public Law 113-79; 128 Stat. 649.

Cousens R (2008) Risk assessment of potential biofuel species: an application for trait-based models for predicting weediness? *Weed Science*, **56**, 873–882.

Criddle EJ (2011) When delegation begets domination: due process of administrative lawmaking. *Georgia Law Review*, **46**, 117–212.

Davis MA (2009) *Invasion Biology*. Oxford University Press, Oxford.

Davis MA, Thompson K (2000) Eight ways to be a colonizer; two ways to be an invader: a proposed nomenclature scheme for invasion ecology. *Bulletin of the Ecological Society of America*, **81**, 226–230.

Davis AS, Cousens RD, Hill J, Mack RN, Simberloff D, Raghu S (2010) Screening bioenergy feedstock crops to mitigate invasion risk. *Frontiers in Ecology and the Environment*, **8**, 533–539.

Endres JM (2011a) Agriculture at a crossroads: energy biomass standards and a new sustainability paradigm? *University of Illinois Law Review*. Available at: http://ssrn.com/abstract=2256148 (accessed 1 February 2014).

Endres JM (2011b) No free pass: putting the 'bio' in biomass. *Natural Resources & Environment*, **26**, 33–38.

Endres AB, Mccubbins JSN, Quinn LD (2012) Definitional debates and uncertainty for would-be biofuel producers. Farm Doc Daily, Available at: http://www.farmdocdaily.illinois.edu/2012/05/definitional_debates_and_uncer.html (accessed 9 July 2013).

Engau C, Hoffmann VH (2009) Effects of regulatory uncertainty on corporate strategy—an analysis of firms' responses to uncertainty about post-kyoto policy. *Environmental Science & Policy*, **12**, 766–777.

EPA (2013) Regulation of fuels and fuel additives: additional qualifying renewable fuel pathways under the renewable fuel standard program; final rule approving renewable fuel pathways for giant reed (*Arundo donax*) and napier grass (*Pennisetum purpureum*). *Federal Register*, **78**, 41703–41716.

GISP (2007) Assessing the risk of invasive alien species promoted for biofuels. In: Global Invasive Species Programme white paper. pp Available at: http://www.gisp.org/whatsnew/docs/biofuels.pdf (accessed 20 June 2012).

Glaser A, Glick P (2012) *Growing Risk: Addressing the Invasive Potential of Bioenergy Feedstocks*. National Wildlife Federation, Washington, DC.

Gordon DR, Tancig KJ, Onderdonk DA, Gantz CA (2011) Assessing the invasive potential of biofuel species proposed for Florida and the United States using the Australian Weed Risk Assessment. *Biomass and Bioenergy*, **35**, 74–79.

Gordon DR, Flory SL, Cooper AL, Morris SK (2012) Assessing the invasion risk of eucalyptus in the United States using the Australian Weed Risk Assessment. *International Journal of Forestry Research*, **2012**, 1–7.

Heaton EA, Clifton-Brown J, Voigt TB, Jones MB, Long SP (2004) *Miscanthus* for renewable energy generation: European Union experience and projections for Illinois. *Mitigation and Adaptation Strategies for Global Change*, **9**, 433–451.

Ifas Invasive Plant Working Group (2013) IFAS assessment of non-native plants in Florida's natural areas. Available at: http://plants.ifas.ufl.edu/assessment/ (accessed 1 February 2014).

ISAC (2009) Biofuels: cultivating energy, not invasive species. Available at: http://www.invasivespecies.gov/global/ISAC/ISAC_whitepapers.html (accessed 11 January 2012), National Invasive Species Council.

IUCN (2009) *Guidelines on Biofuels and Invasive Species*. IUCN (International Union for Conservation of Nature), Gland, Switzerland.

Koop AL, Fowler L, Newton LP, Caton BP (2012) Development and validation of a weed screening tool for the United States. *Biological Invasions*, **14**, 273–294.

Langeland KA, Cherry HM, Mccormick CM, Craddock Burks KA (2008) *Identification and Biology of Nonnative Plants in Florida's Natural Areas*. University of Florida - IFAS Pub SP 257.2008, Gainesville, FL.

Leung B, Lodge DM, Finnoff D, Shogren JF, Lewis MA, Lamberti G (2002) An ounce of prevention or a pound of cure: bioeconomic risk analysis of invasive species. *Proceedings of the Royal Society of London Series B: Biological Sciences*, **269**, 2407–2413.

Lodge DM, Williams S, Macisaac HJ *et al.* (2006) Biological invasions: recommendations for US policy and management. *Ecological Applications*, **16**, 2035–2054.

Low T, Booth C, Sheppard A (2011) Weedy biofuels: what can be done? *Current Opinion in Environmental Sustainability*, **3**, 55–59.

Mack RN, Erneberg M (2002) The United States naturalized flora: largely the product of deliberate introductions. *Annals of the Missouri Botanical Garden*, **89**, 176–189.

Mccubbins JSN, Endres AB, Quinn L, Barney JN (2013) Frayed seams in the 'patchwork quilt' of American federalism: an empirical analysis of invasive plant species regulation. *Environmental Law*, **43**, 35–81.

PIER (2013) US forest service, pacific island ecosystems at risk (PIER). Available at: http://www.hear.org/pier/ (accessed 16 April 2013).

Pimentel D, Zuniga R, Morrison D (2005) Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*, **52**, 273–288.

Quinn LD, Barney JN, Mccubbins JSN, Endres AB (2013) Navigating the 'noxious' and 'invasive' regulatory landscape: suggestion for improved regulation. *BioScience*, **63**, 124–131.

Quinn LD, Gordon DR, Glaser A, Lieurance D, Flory SL (In Press) Bioenergy feedstocks at low risk for invasion in the US: a 'white list' approach. *BioEnergy Research*, doi: 10.1007/s12155-014-9503-z.

Raghu S, Anderson RC, Daehler CC, Davis AS, Wiedenmann RN, Simberloff D, Mack RN (2006) Adding biofuels to the invasive species fire? *Science*, **313**, 1742–1742.

Rice PM (2008) Model weed law provisions for management of new invaders, rapid response, and cost-effective allocation of public resources. Working Paper 2008, Available at: http://www.weedcenter.org/funding/docs/FinalReports_8_08/2006%20Research%20Grant%20Reports/Rice_P_%20final_report.pdf (accessed 16 July 2014).

Richardson DM, Pysek P, Rejmanek M, Barbour MG, Panetta FD, West CJ (2000) Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions*, **6**, 93–107.

RSB (2013) *RSB Principles & Criteria for Sustainable Biofuel Production*. Roundtable on Sustainable Biomaterials, Geneva, Switzerland. RSB reference code: [RSB-STD-01-001 (Version 2.0)].

Secchi S, Babcock BA (2007) Impact of high crop prices on environmental quality: a case of Iowa and the Conservation Reserve Program. Working Paper - Center for Agricultural and Rural Development, Iowa State University.

Simberloff D (1996) Impacts of introduced species in the United States. *Consequences*, **2**, 13–22.

Simberloff D (2008) Invasion biologists and the biofuels boom: cassandras or colleagues? *Weed Science*, **56**, 867–872.

Simberloff D, Von Holle B (1999) Positive interactions of nonindigenous species: invasional meltdown? *Biological Invasions*, **1**, 21–32.

Warren CR (2007) Perspectives on the 'alien' versus 'native' species debate: a critique of concepts, language and practice. *Progress in Human Geography*, **31**, 427–446.