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SPEA-V 499 Honors Thesis

Policy Process of Invasive Species Laws in Indiana

I. Abstract

Invasive species are an ecological threat of growing concern in the environmental policy field. Not only do they cause substantial ecological damage, but they are also extremely costly to manage. Just in the United States, the financial impact of all terrestrial invasive species is estimated to be $133 billion annually (Olson, 2006). Invasive plant species alone, which will be the focus of this research, cost the nation an estimated $34.5 billion annually (Olson, 2006).

There is a large discrepancy between the number of species deemed invasive by science and by law. The U.S. Department of Agriculture designates 112 plant species as invasive, while scientific estimates put the total count at around 5,000 (Schlessinger & Bryan, 2016). This discrepancy is reflected in the multi-level policy approaches to managing invasive species. Instead of comprehensive federal legislation, the U.S. functions with a patchwork of state and local laws, regulations, and programs (Corn & Johnson, 2013). State laws tend to be narrowly focused, banning specific species, limiting their introduction, or responding to what is affected by the invasive species (Corn & Johnson, 2013). In the last 11 years, five Midwestern states passed expansive invasive species laws. Those regulations made it illegal to sell, gift, barter, exchange, distribute, transport, or introduce designated plants within each state (USDA, 2020). However, there are discrepancies in the invasive plants banned by each state, even though ecosystems in the Midwestern region face the same variety of invasive plants.

This research will attempt to identify the relationship between all actors involved in the process of influencing, enforcing, and responding to invasive species bans. Through interviews, document analysis, and

analysis of empirical data, this research will determine the driving factors of the plant industry's migration away from invasive species in the Midwestern region. To limit the scope, this research will qualitatively analyze the trends in Indiana's plant market based on responses from nursery industry experts. It will attempt to identify the main factors that drive invasive species out of a state's nursery industry. Some of the potential factors include conservative versus liberal administrations, change in consumer demand due to education about invasive species, and change in nursery's stocking of invasive species due to speculation about future invasive species laws.

II. Literature Review

Definitions of Key Concepts

Invasive Species

Invasive species are non-native species that threaten ecosystems, habitats, and other species (CBD, 2008), and can also have large economic and human impacts (Pimentel, 2005). In particular, invasive plants pose major ecological threats to native plants on all scales – from smaller communities to global populations (Miller & Gorchov, 2004). They have become a focal point in attempts to conserve and maintain biodiversity in ecosystems, given their negative impacts on native species (Swab et al., 2008). They are characterized by aggressive qualities and tendencies to outcompete native plants for resources, though specific tactics vary between species (Swab et al., 2008). When planted, they spread by seeds, bulb, or other vegetative modes, naturalize themselves into an ecosystem, then degrade natural communities, reduce habitat value, and threaten endangered species (Senator & Rozenberg, 2017).

The direct economic impacts of invasive plants are difficult to evaluate, but the primary metric of measurement is often in loss of crops or forests directly associated with plant invasions (Senator & Rozenberg, 2017). Costs are also incurred from lost ecological services, such as pollination, water purification, erosion prevention, flood and drought mitigation, and climate mitigation (Pejchar & Mooney, 2009). Just in

the United States, the economic impact of invasive plants alone is estimated to be over $34 billion annually (Pimental et al., 2005).

Invasive Species Management

The simplest models of invasive species management define the status of invasion by its size, which determines the treatment (Olson, 2006). Some control methods involve chemical, biological, mechanical, manual, or other means of removal (Olson, 2006). These forms of management, however, assume the species has already arrived in an ecosystem. This study will focus primarily on public education and restrictive law as invasive species management.

There has been some study on collective action approaches to managing for invasive species, though the research is limited. The responsibility for this type of management is typically allocated to local governments, but certain limitations arise from monocentric approaches (Marshall et al., 2015). Local governments often lack the capacity to manage for invasive species when they cross domains of landholders and community organizations (Marshall et al., 2015). Polycentric approaches, those that involve multiple levels of government in developing natural resources management solutions, are seen as the most effective means of invasive species management (Nagendra & Ostrom, 2012).

Many academics believe effective control is only possible with a national strategy and federal regulatory acts to establish uniform approaches to evaluate risks of alien species spread (Senator & Rosenberg, 2017). A well-developed legislative basis is seen as the proper means for determining roles, rights, responsibilities and powers when disseminating efficient preventative measures (Senator & Rosenberg, 2017). There is a major hole in the literature, though. The perspective of plant industry experts tends to be neglected. These extrapolations are often thought up by policy experts, and not those who enforce or maintain compliance within invasive plant laws. The way these actors perceive the process is vital to understanding how to

improve it. This study will attempt to either validate or disprove these claimed based on responses from multiple plant industry perspectives.

Invasive Species Laws

Invasive species laws can be enacted on local, state, and federal levels. A 2017 Congressional Research Report discussed major U.S. federal laws and regulations and the role of federal agencies in managing invasive species (Corn & Johnson, 2017). Invasive species are also regulated by various laws of particular states, often with implementation assistance from federal agencies (Senator & Rosenberg, 2017).

When attempting to regulate the spread of invasive plant species within local ecosystems, there tend to be two types of laws: noxious weed laws that ban a set list of species, and state rules that regulate more specific activities with those weeds (Schlessinger & Endres, 2016). Noxious weeds, as defined by the Illinois Noxious Weed Act, are any plant species determined to be "injurious to public health, crops, livestock, land or other property" (2016). These acts typically place the responsibility of control and eradication of noxious weeds on landowners (Schlessinger & Endres, 2016). Other regulatory weed laws tend to focus on the conservation of native plants and prohibit the purchase, sale, or distribution of plants deemed exotic (Schlessinger & Endres, 2016). This research will focus on the latter - state laws that prohibit and regulate actions with weeds deemed injurious to local ecosystems, human health, and economies.

Plant Markets and Industry

While plants can germinate and maintain populations naturally, a large and diverse quantity of commercially available native plant germplasm is required to facilitate global restoration (White, Fant, Havens, Skinner & Kramer, 2018). The United States meets this demand as the world's largest producer of nursery and floral crops, with over 840 plant vendors nationwide (White et al., 2018). The expansive commercial market sells over 6,000 vascular plant taxa native to the U.S. The Midwestern region has a well-developed market, selling roughly 74% of over 1,000 target species (White et al., 2018). Restoration ecologists view the Midwestern

plant market as a model for restoration efforts. However, it is not without its downfalls, which are addressed below.

Context and Prior Research on Invasive Species Industry

Along with native plants, the horticulture industry supplies and sells ornamental species that are not native to the U.S., introduced primarily for their aesthetic value (Niemiera & Holle, 2009). The ornamental horticulture industry may be responsible for introducing thousands of nonnative plant species to the U.S., many of which have proven to be highly injurious (Niemiera & Holle, 2009). Of the 235 known woody invasive species in the U.S. today, 85% were introduced by the nursery industry (Reichard, 1997). Ecologists estimate that up to 83 percent of the invasive total taxa in the U.S. have a horticultural origin (Bell et al., 2003)

The nature of the market presents the industry with both a responsibility to be environmentally diligent and to make profit (Niemiera & Holle, 2009). A politically and economically potent force, the industry employs thousands of people and generates substantial tax revenues for the government (Niemiera & Holle, 2009). A lucrative point of marketing in the industry is new and novel plant introductions (Niemiera & Holle, 2009). This demand stimulates efforts from the horticulture industry to seek out new species, usually from outside the country. Efforts have been made to impose limitations on new plant introductions through use of internet-scanning software, but these efforts have not proven to be successful. Many stakeholders do not believe invasive species are as detrimental as scientists claim, which might be because the regulatory agencies tasked with enforcing restrictions on invasive species receive tax revenue generated by the sale of nonindigenous species. The industry is driven by demand, though, and gardeners tend to by what they are familiar with. If the public becomes aware of these practices, nurseries may alter their practices and reduce their sale of nonnatives. (Niemiera & Holle, 2009; Reichard & White, 2001)

The literature on what drive the invasive species industry poses many questions with few answers. The for-profit plant industry is faced with the ethical dilemma of selling plants that have the potential to degrade local ecosystems. The state and federal regulators are tasked with identifying which species should be regulated.

Politicians must consider the economic impact faced by growers when they are forced to cease the sale of plants in demand. To mitigate the differing interests of these parties, a conversation must be initiated.

Context and Prior Research on Invasive Species Laws

In order to understand what drives invasive species policy on a state or local level, it is important to know the history of invasive species directives on a federal level. Federal policy can both influence local policy and be influenced by local policy. Regulation of invasive species has gone through continuous phases of being more and less restrictive. The type of administration plays a meaningful role in setting an agenda for environmental regulators to follow. The following section will first provide a brief timeline of federal directives regarding invasive species, and then focus more narrowly on state approaches to invasive species laws.

Federal Laws and Directives

The first US law regulating the control of invasive species was the Forest Service Organic Administration Act of 1897. Its intent was to provide broad authority to the U.S. Forest Service to preserve forests as working ecosystems with multiple objectives and protect forest lands from several threats, including invasion by terrestrial plant species (Corn & Johnson, 2013).

After the Organic Act of 1897, five more laws governing invasive species management were passed by 1939. Together, they granted a range of authorities to federal and state agencies to address illegal wildlife trade, ban certain species, control damage caused by invasive wildlife on all land, and require accurate branding and purity standards for seeds in commerce (Corn & Johnson, 2013).

After the Federal Seed Act of 1939, there was a 31-year period of federal inaction with regard to invasive species law and regulation (Corn & Johnson, 2013). The tumultuous events of the early half of the 20th Century were a prelude to the Greed Decade of the 1970s and the maturation of the Conservation Movement. Technological advancements made environmental issues more accessible to the general public.

Television newscasts covered a range of environmental disasters, resulting in increased public awareness and a decade of Congressional action on environmental issues.

The National Environmental Policy Act (NEPA) of 1970, required federal agencies to consider the environmental impacts of any "federal action," which applied to invasive species control programs and projects (Corn & Johnson, 2013). Following NEPA, five more federal laws were enacted by 1978 (Corn & Johnson, 2013). Collectively, they limited federal and individual actions involving invasive species, required federal agencies to establish and fund noxious weed management, and supported good forest management practices to prevent establishment of invasive species (Corn & Johnson, 2013).

After the Green Decade, there were 12 years of federal inaction with regard to invasive species legislation. With globalization and growing public concern for environmental issues, the environmental movement started to become institutionalized (Kline, 2011). Between 1990 and 2004, nine federal laws with invasive species provisions were enacted, as well as one executive order directed by President Bill Clinton in 1999 (Corn & Johnson, 2013). These acts included more specific invasive species control measures than any laws preceding them. They established grant programs to financially assist weed management entities, prohibited the interstate movement of invasive species, and created a national management program to prevent the spread of invasive species into U.S. waterways (Corn & Johnson, 2013). Over 40 percent of all federal acts regarding invasive species were adopted after 1990. This era gave way to continued and expanded action by state agencies, municipal governments, and multi-scalar environmental groups.

The U.S. Forest Service, under the jurisdiction of the Department of Agriculture, plays an important role in the management of invasive species across the country. Under the Cooperative Forestry Assistance Act of 1978, the Forest Service can enter agreements with other federal, state, and private entities to support their control and management of invasive species (Corn & Johnson, 2013). Further, it authorizes the USDA to technically assist and manage insect infestations on federal lands (Corn & Johnson, 2013).

State Approaches

State laws tend to be narrowly focused, banning individual species, limiting their introduction, or responding to what is affected by the invasive species (Corn & Johnson, 2013). This research will focus on those state laws which prohibit the sale or planting of listed species. To limit the scope, this research will focus on recent laws and regulations enacted in Midwestern states in the last 10 years. When looking at the effects of invasive species law changes in Indiana, it is important to understand the legislation that is being created in neighboring states. Many Midwestern states face invasions by many of the same invasive species, so it is important to note when there is a disparity between states' banned species.

Wisconsin

Issued by Wisconsin's DNR, Administrative Code NR 40 prohibited the possession, transportation, transfer or introduction of 68 new invasive species without a permit, bringing the total number of restricted species to 145 (Wisconsin DNR, 2015). The rule authorized Wisconsin DNR to issue permits for approved use of listed invasive species if the applicant is knowledgeable of proper management of the species, can contain the species, and demonstrates the permitted activities will not cause significant harm to humans, ecosystems, or the economy (Wisconsin DNR, 2015).

Illinois

The Illinois Exotic Weed Act is the primary means by which the state regulates activities involving invasive plant species that threaten Illinois' terrestrial habitats (Evans, 2016). Under jurisdiction of the Illinois DNR, the Act, as amended in 2015, established a list of 26 regulated exotic weed species and banned the sale, purchase, distribution and planting of any listed species (Evans, 2016). The Illinois DNR may issue permits for the purpose of research or for the sale of select species, but individuals who violate their permits or the Act are subject to a Class B misdemeanor (Schlessinger & Endres, 2016).

Ohio

Under Ohio Administrative Code 901:5-30-01, the director of Ohio's Department of Agriculture (DA) declared 38 plant species to be invasive. This rule, effective in 2018, prohibited the sale, propagation, distribution, importation, or intentional dissemination of all listed species (OAC, 2018). The Ohio DA may

issue compliance agreements to individuals pursuing the use of listed plants for research or educational purposes (OAC, 2018). This rule also established a committee to advise the Ohio DA on invasive plant matters (OAC, 2018).

Minnesota

Minnesota's invasive species regulation is unique because it is the only state in this study whose Noxious Weed Law prohibits the sale, transport, or propagation of listed species in one piece of legislature. All other states separate their Noxious Weed Laws from other acts or regulations that ban certain activities involving previously listed species. Minnesota Statute, Section 18.75-91 is cited as the "Minnesota Noxious Weed Law." With major amendments passed in 2013 and 2020, the Law establishes five noxious weed categories, of which three prohibit the sale, propagation, importation, or transportation of all 44 species falling into those categories (Minnesota Noxious Weed Law, 2020).

Indiana

The Terrestrial Plant Rule (312 IAC 18-3-25) designated 44 plant species to be invasive pests in the state of Indiana (IAC, 2019). It banned the sale, bartering, exchange, distribution, transportation, and introduction of any listed plant. Violation of this rule subjects the violator to a fine of $500 per incident per day (IAC, 2019). The rule went into effect on April 18, 2019 but species already in trade were not prohibited from sale until one year later, on April 18, 2020. This intermittent period provided nurseries time to sell out their current stock of listed invasive species instead of being forced to destroy the inventory. This was a tactic of Governor Eric Holcomb's office to minimize the financial burden of this rule on the plant industry.

Other Important Factors

It is important to acknowledge the influence of public attitude on invasive species regulation and demand. Some cities and states preemptively restrict certain plant species if they are banned by surrounding states. Simultaneously, environmental groups may conduct "smear campaigns" against species that are known to be invasive but are not regulated by state or local law. Commonly defined as slanderous campaigns aimed at tarnishing a reputation, these smear campaigns tout the dangers of unregulated invasive plant species (Collins

Dictionary, 2005). These organized efforts, while localized and small, are said to hold sway on awareness of and demand for invasive plant species.

III. Description of Main Variables and Measurement

Given this study is utilizing interview responses and document analysis to identify the major factors driving invasive species laws, it is difficult to identify a direct relationship between any two variables. The nature of the research question does not necessarily seek out a causal relationship but seeks to identify variables that could be correlated with invasive species law change in future studies. With that in mind, the variables and considerations relevant to the research questions are described below.

Invasive Plant Laws

The independent variables for this research are invasive plant laws. Specifically, the restrictive invasive species laws of Midwestern states, as described in the "State Approaches" section of the literature review. The variation in these state laws and their dates of enactment do not depend on the variation of the invasive species market – they are drafted and enacted regardless of the trends in plant sales and demand. These variables will be measured by their year of enactment. For the purpose of this study, the Midwest region consists of these 8 states: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. Five of these states have passed major invasive species laws or amendments in the last 10 years. These are the laws that will be used as independent variables in this study. Minnesota will contribute two years as independent variables because there were two major amendments to its invasive plant list within the last ten years.

It is important to acknowledge Indiana's Terrestrial Plant Rule, but it will not be included as a main variable in this study for the logical problem it poses with the overarching research question. The effect of Indiana's invasive plant law on the demand for invasive plants in Indiana would theoretically drive demand to zero.

State	Law	Year Enacted
Wisconsin	Wisconsin Administrative Code NR 40	2015
Illinois	Illinois Exotic Weed Act (525 ILCS 10/)	2015
Ohio	Ohio Administrative Code 901:5-30-01	2018
Minnesota	Minnesota Noxious Weed Law, Minn. Statute, Section 18.75-91	2013 & 2020

Other Variables Potentially Influencing Demand

Invasive species laws in neighboring states could certainly play a major role in public awareness and attitude about invasive species, but there is evidence that public education initiatives and smear campaigns from local environmental groups drive demand as well. Using smear campaigns and education initiatives as independent variables could prove to be difficult, given a precise start year is needed for proper measurement. It is also likely these initiatives begin in the same years major invasive species laws are passed, so sifting out the magnitude of effects from each factor would be difficult, given the scope of this project. The nature of the interview data collection method for this study allowed respondents to identify all factors that might play a role in changing demand for invasive species. These other factors will be identified in the Findings section of this paper.

Invasive Plant Market

The variation in this market is dependent on many factors. Interviewees will be asked to qualify their understanding of how the Indiana market changed when restrictive invasive species laws were passed in surrounding Midwestern states. Different invasive plant market indicators can help visualize the effects of laws and other factors. The best indicator of demand would be invasive plant sales, but this data was not available for multiple years.

Inventory & Sales

Inventory changes will indicate trends in supply and growers' expectations of future demand. If the interviewees can speak specifically about the inventory held in invasive species at their nursery, it will be measured as the total dollar value of a grower's inventory of invasive species. For continuity and consistency, interviewees will be asked about inventory of only the 12 invasive species listed in Table 1. These plants were deemed to be highly invasive by Indiana Native Plant Society but are not regulated by Indiana DNR. Sales data would provide direct insight on the public's demand for invasive species. If this data can be spoken on by the interviewees, it will be measured by the dollar value at which a grower or nursery sold each of the 12 plant species.

Other Qualitative Measures

The format of the interviews allows the interviewees to identify other mechanisms and concepts that shape how the different actors within the plant industry interface with each other. These other measures of invasive plant market change are discussed in the Findings section of this paper.

Hypothesis

Industry experts and regulators will identify restrictive invasive species laws in states neighboring Indiana as highly important to influencing invasive species regulation in Indiana. The rationale for this hypothesis is that a rise in public awareness of specific invasive species in the region will decrease an individual's desire to by the species. Once there is a change in demand for an invasive species, regulating entities like DNR will likely be influenced to support banning those species. This hypothesis is informed by informal conversations with Indiana DNR's regional inspectors. Some claim to have already seen a decline in the sale of invasive plants over recent years due to public education initiatives arising in response to invasive plants being added to neighboring states' banned list and not to Indiana's banned plant list. The rationale behind this argument is that individuals who are made aware of the detriment a species can cause, even if their means of learning was through another state's legal ban of the species, will no longer want to purchase or plant that species.

IV. Data Collection Method

Invasive Plant Laws: Document Analysis

The data collection method for invasive plant laws was a simple document analysis. This stage of data collection is already complete, as reported in the "Independent Variable" section of the variable description and in the "State Approaches" of the literature review. The full text of Minnesota's state statute, including all amendments, was found on the Office of Revisor of Statutes page of Minnesota's official government website. Wisconsin's Administrative code was pulled from the state's Division of Natural Resources website, which linked to the full invasive species rule on Wisconsin's official government website. Illinois' Compiled Statute for its Exotic Weed Act was found on the Illinois' General Assembly government website. Ohio's Administrative Code was found on the state's official government website.

After the laws were accessed in their appropriate amended states, the invasive species provisions were found and analyzed. These sections typically included a full list of regulated species, the regulations on activity with those species, and the dates of enactment. These are the only three pieces of information needed from the invasive species laws.

Invasive Plant Market: Interviews

Interviews were conducted with 10 different experts. All names were left out of this report to respect the anonymity of the individuals' who responded to interview questions. Six interview participants worked as Indiana DNR Nursery Inspectors and Compliance Officers from various regions in Indiana. See Figure 2 for a map of all IDNR Compliance Officers and IDNR regions. Three individuals currently working in the for-profit 'green industry' (landscapers, plant growers, turf maintenance people, etc.) were interviewed: a sales representative from a commercial nursery in Indiana; a president of a private landscaping and environmental consulting firm who also serves as a chairperson on the Wisconsin Invasive Species Council; and an inside salesperson at a commercial nursery in Ohio. Including industry experts from states neighboring Indiana provides direct insight on the differences in how states manage invasive species on an industry level and respond to different invasive species laws. These experts were able to speak on their different interactions with state regulators and politicians, as well as describe their respective processes for phasing out newly banned species. With that, all industry experts outside of Indiana had either worked in Indiana's plant industry at some point in their career, or directly interfaced with Indiana growers on a regular basis in their current position. One expert from the nonprofit side of invasive species management and regulation was included in the interviews. This expert has spent spent over 20 years working as an ecologist and was included in the conversations with DNR and green industry representatives when Indiana's Terrestrial Plant rule was first introduced.

All interview participants were initially contacted by email. Green industry workers were asked to meet over an hour-long zoom call. All IDNR compliance officers were interviewed via email. The nonprofit

representative was also communicated with via email. The three industry experts were asked many of the same interview questions, but some substitutions were made if the interviewee worked outside of Indiana. See List 1 for the original list of questions posed to nursery experts. Responses were coded and compared in an excel sheet.

IDNR officers were asked about any longitudinal data on plant sales or inventory, given the data in Table 1 had just been released. They were asked a more general set of questions. They were asked to identify, in their view, who the main drivers of invasive species law change and who they thought was the most influential party in driving invasive species demand. They were given the opportunity to speak freely about any trends they had observed during their time working with IDNR.

All interview participants were given the opportunity to speak freely and qualitatively about anything they felt was relevant to the study. This open-ended section of the interview process is intended to identify qualitative variables that might either contribute to the observed changes in the invasive plant market or influence invasive species policy. This could include the relative importance of restrictive laws over public education and awareness initiatives. The growers could identify times when local environmental groups conducted smear campaigns against a particular species. Their responses were coded according to topics mentioned and compiled on a large datasheet.

V. Findings

Regulator's Perspective

It became clear very quickly that longitudinal datasets on invasive species sales and inventory did not exist. IDNR Compliance Offers were asked about any longitudinal datasets that would show consumers' demand for invasive species (sales, inventory, etc.). These purpose of collecting these data was to continue the data table IDNR had already started. Table 1 is the Invasive Species Grower Survey, which shows the total number of individual invasive plants held by 9 different growers in Indiana. The survey was conducted by

Indiana DNR Division of Entomology and Plant Pathology (DEPP) compliance officers and compiled by Division Director & State Entomologist of Indiana DNR, Megan Abraham. Data were collected between the months of January and November of 2020. When compliance officers were asked if these data had been collected for any prior years, all respondents said no. One nursery inspector replied:

> "No inspector will have numbers of what's for sale and what's not now vs before the terrestrial rule went into place. Any information we would have would mostly be antidotal about what we think we've seen."

A different compliance officer offered some justification, quoted below.

> "Until the summer of 2020 we did not have an invasive plant rule and therefore did not hold/destroy any plants within the nursery trade. When we conduct our nursery inspections, we do not take an inventory of the plants at each grower and dealer location."

This data was only being collected to keep track of the species being phased out and to gauge the economic impact of potential species bans.

Compliance officers were then asked to provide general information on how the plan industry functions in Indiana and to share any unique features of the market. A compliance officer from Southern Indiana explained the structure of Indiana's plant industry. There are relatively few large growers in the state, but as a rule, the nursery industry (those who grow and sell) must remain relatively small compared to states like Michigan and Ohio. The rationalization for this "rule" was that surrounding states have vastly more acres of nursery production (plant growing), while there is much more buying and reselling of nursery stock in Indiana. "Much of the plant material sold in Indiana is imported and sold at nursery dealer such as Lowes, Menards, Home Depot, Rural King, Wal-Mart etc.," the compliance officer said. These commercial industries sell a large amount of nursery stock in the state, including noninvasive and invasive plant species. When asked about demand for invasive plant species across the state, the compliance officers believed it would vary from county to county.

This compliance officer's rationale for the difference in demand for invasive plants across the state the difference in education programs across counties. "Customers in those regions are demanding alternative species while other areas of the state have more demand for invasive species," they said. Most IDNR officers shared the same sentiment. Another compliance officer argued the main power of invasive species bans came from the education of the public. "In my experience, educating the public about the issue surrounding [invasive plants] is the lynch pin. Once a person is educated about it, they don't want to buy those species and when demand for the species dries up the industry shifts to production of other plants." While the percent of the public that is concerned about invasive plants is growing, many officers emphasized how the for-profit nursery industry would always choose to grow and sell what was in demand until they are prohibited by regulation. It is in their self-interest to provide a product to consumers, and many consumers remain unaware of the detrimental effects of planting invasive species. Some compliance officers were optimistic about the shift towards buying and planting natives, saying "I think the general public is becoming more educated about the problems invasive species cause to our natural areas and are starting to request more native species when they go shopping for plants." They believed plant inventories were shifting away from some of the highly invasive exotic species and towards native species.

Regardless of how the public is driving demand with their spending habits, the primary prohibitor of invasive species circulation is invasive species law. IDNR officers were asked to give their perception of the law process, explain who they believed to be the most important actors in driving new laws, and identify any inefficiencies in the process. One officer provided a unique anecdote by saying, "the laws are necessary to be able to enforce compliance because there will always be some individuals who will refuse a reasonable argument or just don't care." This is the basic function of invasive species laws - prevent the nursery industry from circulating species that are environmentally harmful and must be banned by law. Another officer provided a short narrative of their experience during the process of revising the Indiana Terrestrial Plant Rule in April of 2019. The process was long and arduous, and the political landscape was difficult to navigate. The response is quoted below.

> "In Indiana, our last few Governors worked on the idea that new laws should have a minimal financial burden on any industry. So, when the first round of the Terrestrial Invasive Plant Rule came through, we had to drop several species off to get the financial impact below the threshold the Governor's office would accept. We took what we could get to get the rule passed. One of those we dropped was Callery Pear. So now it is back on the list for inclusion in the second round, which could be two years from now, five years – who knows when that will finally happen..."

The drop of this species was not met with silence. Several cities in Indiana voluntarily restricted Callery Pear and some environmental groups conducted "smear campaigns" against the flowering pear. "This is having an effect on awareness and demand," the officer said. Regarding Callery Pear, nurseries know the species is an issue and that it is a target for regulation in the next invasive species ban. The same officer described the nursery industry's reaction to the Callery Pear situation:

> "Most are selling out what they have because if restricting Callery is inevitable, maybe it's best to sell out of it now rather than keep it in stock and have to destroy 20-30 trees when the law does come through. Finally, some honest discussion of invasive species and the roll of the nursery industry in their spread is starting to happen."

This officer believed the threat of banning the tree might have had as much impact on the species' sales as if it were restricted by law. Many advocacy groups became "aggressively vocal" about the threats posed by the species, "which might have had even more impact on the Invasive Species cause as a whole than if pear had gone away quietly," said the officer. This entire process of threatening to ban the species might make it easier to ban the species in coming years because much less inventory will be held at the nurseries. "Seems kind of backwards, but the court of public opinion might have done far more to move the needle on restricting invasive species than the mere threat of a regulation," an officer said of the process.

Summary of Regulator's Perspective

Overall, IDNR officers placed a lot of weight on public education in driving invasive species demand and law change. The primary actors they pinpointed as essential to driving the process were environmental nonprofits and the public communities they educate.

Nursery Industry Perspective

Experts in the nursery industry offered a vastly different perspectives on the main drivers of invasive species demand and regulation change. All three nursery industry experts interviewed acknowledged how they worked a for-profit industry with a personal interest in making a profit. They all wished to supply plant species to consumers who have a demand for those species. The conversation gets complicated when the invasive versus native plant species issues are involved. Responses varied on how experts viewed the relationships between nurseries, regulators, political figures, and the public.

Each nursery decided what species they wanted to sell or grow for their consumer base. They can sell any species that isn't currently on their state's banned list. When the experts were asked if their nursery chose to voluntarily reduce inventory of known invasive species, responses varied. The representative from Wisconsin said that nurseries would not voluntarily reduce their inventory of species that are in demand. This person believed growers would grow invasive species up until the last possible day they were permitted to grow a species, reasoning that it is in their financial interest to do so. This expert believed it came down to who was running the nursery to decide their stance on invasive versus native plant sales, as some native-focused nurseries may choose to promote species that are not commercially popular.

The industry representatives from Ohio and Indiana said their nurseries would preemptively try to sell out a species if they knew it could potentially be banned in the coming years. Apparently, it becomes common knowledge to nurseries when a species is considered for bans, so growers can get a sense of when the ban is coming and are given time to sell out a species. However, this knowledge does not mean growers preemptively reduce their inventory. As with Callery Pear, some growers push back and resist the possibility of species bans due to the profits they incur from selling certain species. When species are banned, though, growers are given a specified amount of time to sell out their inventory of the newly banned species. If they own stock of those banned species when their grace period ends, IDNR will destroy the remaining inventory. For the Indiana Terrestrial Plant rule in 2019, the sell-out period was one year. The primary loss to the

nursery industry when a species is banned is foregone profit from not being able to sell plants. Invasive plants that are banned are often easier and less expensive to grow. Growers are forced to move from a cheaper to produce plant and to something where the losses from growing are higher. A nursery expert pointed out how there is typically less public demand for native species. Natives are not as cheap and tend to be less "flashy" than many Eastern non-native species. With that, the nursery expert from Wisconsin discussed the drive amongst competing nurseries to introduce new and niche species. "As growers, there's this excitement to discovering a new cultivar or to be able to name a new cultivar to give yourself a leg up in the industry in driving demand for your product. There's two or three really influential plant introduction plant companies in the industries. So, it's a race to introduce new product all the time to keep yourself more relevant than the others," they said. "Flowers drive our industry. Colors drive our industry. So, if we stopped producing new plants today, I don't think the consumer would ever realize it. So really what's driving the race to introduce new plants is really a selfish thing amongst our industry growers and influencers." The other experts shared the same sentiments. Though they understood the harms of keeping invasive plants in circulation, the nursery industry and those working within it are ultimately driven by turning a profit.

All respondents emphasized the importance of staying in compliance with local laws. They saw the value in eliminating plants that dominate ecosystems. When asked what the most important driver of regulation change was, all three responses varied. One expert believed consumers were the most important actors in changing demand for species being sold. To them, consumers drive the process. Another expert said that regulation was "certainly is driven by the DNR. It's always as a response to seeing the disruption as they see it out in nature, and it's relevant. But it's not all that forward-thinking." They contemplated whether the government entity had done as well as it should have in regulating harmful species. The other expert leaned toward identifying regulations and regulators the most important factor in driving invasive species laws, as the nurseries are a for-profit business that will always sell what is in demand.

When asked to describe the relative importance of public education in driving invasive species demand and local legislation, the experts generally believed it to be a relatively important factor, but not the sole driver of change. Only one expert emphasized the great significance of education. They considered consumers and their relative education to be the most important factor in changing demand for what is being sold. In their view, consumers drive the process. A different expert's response below contrasts with this sentiment.

> "I'd be hesitant to believe that a public drive with consumers about invasives versus noninvasives falls on deaf ears. I don't think most consumers care that much about plant material and natives. I don't know how you get a buy-in from the entire general public. I don't know how important that is."

This individual did not hesitate to place the blame on the nursery industry. They believed it was ultimately up to them to not offer the species. "It's not going to be public-driven. It's going to be industry-driven," they said. They believed the role of public education in driving invasive species demand is significant, but only to a certain extent. They mentioned the importance of public commenting on invasive species laws when they are going through the legislative process. Comments can be "all over the board," and this expert attributed much of the variation to difference in personal politics.

On the topic of politics, the respondents speculated about the role of administrations in driving attitudes towards regulating invasive species. "I have to often wonder the nativism versus invasives is not also a reflection of the politics of our times. Look at where the politics are now," one expert said. "I'm sure that restrictions are tightened up when we have more liberal policies versus conservative policies." They claimed to have seen the "native wave" come and go three or four times since he has been in the industry. The expert from Wisconsin contrasted this idea, claiming to have seen no significant difference between strategies of invasive species management and legislation between democratic and republican governors of Wisconsin. "The goal is not to affect business and industry," they said. Ideally, legislation could be avoided, and councils could pursue what is simply in the best interest of the state's ecology.

Summary of Nursery Industry Perspective

Responses from all three respondents varied relative to each topic of discussion. Overall, though, they placed more importance on the role of DNR in driving invasive species law change. They all acknowledged the fault of nurseries for selling invasive plants in the first place, but do not realistically believe the brunt of the blame can fall on a for-profit business providing products to consumers.

Nonprofit/Local Environmental Group Perspective

The person representing the nonprofit and local environmental group perspective has been the chair of an invasive species management group in Southern Indiana since its creation in 2009. Before that, they were an ecologist for The Nature Conservancy. They have worked for the US Forest Service, held a leadership role on the Indiana Native Plant Society, and has provided expertise on the Invasive Plant Species Assessment Work Group (IPSAWG). They have extensive experience working on the Invasive Plant Advisory Committee (IPAC) to the Indiana Invasive Species Council, which recently replaced IPSAWG.

This representative was contacted by email and asked to offer her input as someone who has worked in the realm of invasive species management, education, and advocacy for decades. They were asked to describe the relationship between nonprofits and DNR officers when it came to planning species bans. They were also asked to include any personal stories that could help qualify the process of invasive species bans as it related to local nonprofits.

This expert chose to describe the entire process of introducing, planning, and passing the Indiana Terrestrial Plant Rule in 2015. "It was around the year 2000 and a group of us fighting invasive plants got together with representatives of the green industry," they said. The former director of DNR – Division of Entomology and Plant Pathology (DEPP) gathered several actors from the nonprofit and regulatory spaces. DEPP regulated the "green industry," as they referred to it. "The overwhelming message that came out of that meeting was 'we will continue to sell these species as long as customers buy them. Educate the public to stop wanting them,'" they recalled. They spent the following 20 years educating the public about invasive species and

starting the process to regulate them. The education initiative had "no measurable impact on sales of invasive plants," thye said. "We tried education with all our might, and it failed to change buying/selling habits. Completely."

They speculated that the initiative might have proven to be more successful if DNR-DEPP had been more involved in the process. "They provided no resources, no educational pieces, no useful information on their website – not even the actual list of invasive plants of Indiana until recently, and after years of pushing." In their view, DNR-DEPP did not see assisting in public education as part of their role in managing invasive species.

This expert believed the main driver of invasive species law change was not education, but the adamance of those in the Invasive Plant Advisory Committee (IPAC) to force the rule forward. They were the actors determining which species would be on the list. IPAC spent thousands of hours between the years 2000 and 2015 assessing plant species. This expert continued to explain how IPAC provided the expertise of leading botanists, as there were none serving in DEPP. They recalled how some DEPP staff were not even familiar with the plant species on the potential ban list. DEPP's dependance on IPAC led to problems with implementing the rule once it was passed. "Getting that rule passed took over 5 years; I believe that was because the DNR did not see this as a priority despite the pushing and pushing and pushing," they said. This expert suspected there might have been pressure from the green industry to stop the law as well.

Summary of Nonprofit/Local Environmental Group Perspective

This narrative suggests that education might not be as impactful as the literature and regulators might suggest. Education changing the demand for invasive species makes sense in theory, but the lived experiences of those trying to educate the public suggest the efforts might be ineffective.

I. Conclusion

Conversations with these different actors in the invasive plant species realm have identified several factors that could be correlated with changes in (a) demand for invasive plant species and (b) invasive species laws. Each representative interviewed (environmental nonprofit, governmental regulatory, and nursery industry worker) placed different values on the relative importance of public education in changing the landscape surrounding invasive plants. Some believed it was the only important factor, while others believed it was a completely ineffective way of creating change in the space. Politics aside, there was an overall attitude that local administrations played a significant role in driving the expansion of invasive species laws. Not one actor believed they held the most sway in changing demand for invasive species or driving law changes.

The research question for this study evolved greatly over time due to lack of available data. The initial research question was "What is the effect of invasive plant laws on the demand for invasive plants in Indiana," which would've been a completely quantitative study. The goal was to identify any statistically significant relationships between invasive species sales in Indiana and the enactment of invasive species bans and regulation in neighboring states. A simple regression was to be run on invasive plant sales in Indiana (the dependent variable) and years of invasive species laws (the independent variable). The unit of analysis was the market growth rate between each year, paying particular attention to years when states neighboring Indiana passed invasive species laws. Extrapolations could've been made about how the external factors identified in this study were correlated with changes in value held in inventory or sales data. Since these data did not exist, these relationships could not be studied. Follow-up studies could focus on collecting these data from nursery owners. Once a complete dataset has been compiled, numerous regressions could be run to determine which factors identified in this study are most correlated with changes in invasive species demand.

Collecting these data and continuing this research is essential to understanding how to create invasive species laws that do not compromise the best interest of a single party involved in the process. Future studies could

use the findings in this research to streamline the process of identifying and managing invasive species for the benefit of people and the environment.

VI. Appendix

Invasive Species Grower Survey

	1	2	3	4	5	6	7	8	9	10	11	12
Grand Total	**13901**	**6937**	**6640**	**0**	**0**	**0**	**0**	**0**	**3657**	**20**	**4891**	**1917**
Stultz	2636	975	880	0	0	0	0	0	35	20	1920	595
Cote	242	4	1060	0	0	0	0	0	0	0	320	105
Biddinger	870	370	245	0	0	0	0	0	0	0	391	455
Bitner	4372	3210	0	0	0	0	0	0	0	0	1035	70
Burkle	1837	931	0	0	0	0	0	0	0	0	738	40
Bontrager	121	0	0	0	0	0	0	0	0	0	16	76
Rust	164	131	0	0	0	0	0	0	0	0	0	55
Hall	859	969	3055	0	0	0	0	0	102	0	89	135
Spokowsky	2800	347	1400	0	0	0	0	0	3520	0	382	386
Maximum	4000	3000	2600	0	0	0	0	0	2000	20	1545	400
# Sites	87	53	38	0	0	0	0	0	8	1	59	48
Average/Site	159.8	130.9	174.7						457.1	20.0	82.9	39.9

Key:

1 - burning bush (Euonymus alatus)
2 - callery pear (Pyrus calleryana)
3 - Chinese maiden grass (Miscanthus sinensis)
4 - highbush cranberry (Viburnum opulus v. opulus)
5 - wild parsnip (Pastinaca sativa)
6 - Japanese hedge parsley (Torilis japonica)
7 - lesser celandine (Ranunculus ficaria)
8 - spreading hedge parsley (Torilis arvensis)
9 - moneywort (Lysimachia nummularia)
10 - sweet autumn clematis (Clematis terniflora)
11 - Norway maple (Acer platanoides)
12 - Fine Line Buckthorn (Rhamnus fragula)

Table 1 - Invasive Species Grower Survey showing total number of individual invasive plants held by 9 different growers in Indiana. Survey conducted by Indiana DNR Division of Entomology and Plant Pathology Stapp, compiled by Division Director & State Entomologist of Indiana DNR, Megan Abraham. Data were collected between 1/1/2020 and 11/17/2020.

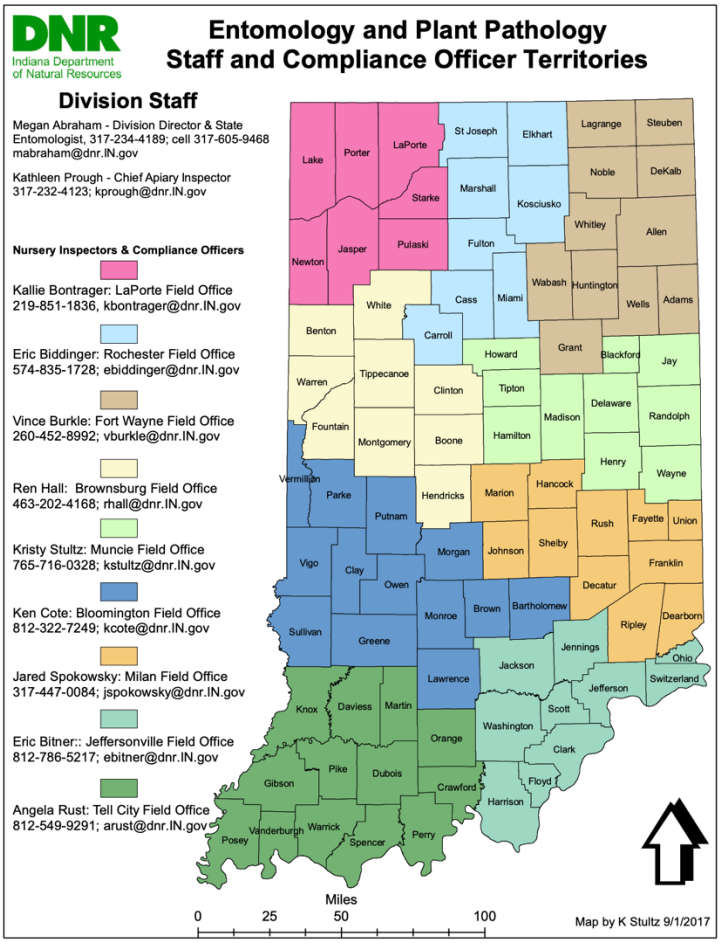

Figure 2 – Entomology & Plant Pathology Staff and Compliance Officer Territories with respective Nursery Inspectors & Compliance Officer contacts.

1. What is your official title?

2. How long have you worked in the plant industry?
3. If you work directly at a nursery, how many known invasive species do you sell?
4. How did you go about mitigating the loss from phasing-out banned species for growers?
5. Do you tend to see nurseries voluntarily reduce their inventory for any of these plant species? If so, why?
6. If you already phased out any invasive plants before the plant rule was passed, what was your motivation for doing so?
7. What are the most significant factors that drive demand for plants deemed to be invasive?
8. What do you believe is the role of public interest and education in decreasing the sale of invasive species in the plant industry?
9. Who do you believe is the main actor driving changes in invasive species laws?

List 1 - List of original interview questions posed to nursery industry experts.

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