**Analysis of adaptive capacity and governance surrounding
an invasive pest, the Emerald Ash Borer, in Iowa**

by

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ABSTRACT

Theories and applications of adaptive natural resource management suggest that collaboration is essential for increasing the capacity of groups (e.g., communities, organizations) to address issues of concern, such as wildfire or the spread of invasive species. Furthermore, an understanding of relationship structure among individuals in these groups helps define opportunities for improved communication and effective response to these issues. In areas of the Eastern and Midwestern U.S., the spread of Emerald Ash Borer is of great concern in both rural and urban areas. Collaboration among stakeholders (e.g., private businesses, state and federal agencies, non-governmental organizations, municipalities, volunteer groups) within these areas will be needed to identify effective response strategies and develop innovative solutions to mitigate the costs associated with the invasive pest. In our study, we first interviewed members of the EAB readiness team (e.g., state- and federal-agency, and university extension staff) to isolate and evaluate aspects of collaboration and coordination that are essential for effective response. We determined that while communication and collaboration issues have largely improved over time, several areas of concern were noted. These included the issues of communication, trust, and role evolution and overlap. We then focused on three separate urban areas to assess the network structure of stakeholders involved with urban trees and wood utilization, while also investigating their willingness and motivation to adapt their work to address the spread of EAB. The focus of our social network analysis includes identifying network heterogeneity, density, aspects of brokerage, and reachability. Our preliminary findings suggest a general lack of collaboration among stakeholders, with notable concern related to relations between public (city services) and private (arborists, nurseries, etc.) stakeholders ; the degree to which these two groups are preparing for EAB is markedly different. Findings from

this project help to identify the full spectrum of stakeholders including those who are peripheral and unengaged; discern information breakdowns as well as isolated actors; identify opportunities to accelerate knowledge flows across functional and organizational boundaries, and; provide the framework for future strategies that address collaboration surrounding emerging natural resource issues of concern.

CHAPTER I: GENERAL INTRODUCTION

Invasive pest management has proven costly and challenging for resource managers around the world, and the number of species of exotic forest pests that affect trees and forests is on the rise (Orwig 2002). In order to combat the imminent threat from these pests, researchers are promoting a number of strategies to address these pests (Anderson 2005). This can be especially challenging as communities and natural resource agency networks are composed of a wide assortment of different stakeholder-actors, all of whom are necessary for on the ground coordination and action management (Simpson et al., 2009.) Due to the diverse stakeholder makeup of these numerous systems and the complexity inherent within the realm of invasive pest management, adaptive management and co-management are widely seen as necessary tools in the natural resource management toolbox (Armitage 2007, Ratner et al., 2012). Consequently, it is essential to build the collaborative capacity of these stakeholders responsible for addressing invasive pests in order to sufficiently approach for their management and subsequent damage mitigation (Folke et al., 2005).

A relatively novel pest, the Emerald Ash Borer (EAB), is the most recent pest to threaten the Iowan landscape. This coleopteran (*agrillus plannipenus*) was introduced to the United States (Michigan) in 2002, and has since destroyed over 50 million ash trees across the eastern and Midwestern United States (MacFarland and Meyer 2003). In Iowa where ash trees compose 15-20% or more of the street trees in communities, EAB promises to be devastating to both state and local level managers alike (IDALS 2013). Substantial economic impact from removal, disposal, and replanting of street trees is to be expected (Nowak et al., 2002).

The research presented in this thesis attempts to address the issue of EAB in Iowa by looking at collaborative management at the state and community level. At the state level we

address such questions as: How are state level managers responding to EAB? How to do state level manager roles affect their management decisions? How has collaboration amongst these managers been constrained in the past, and how can collaboration be improved in the future? At the community level we asked: How close do you think EAB is to your city? How do you think EAB will impact your business, whether positive or negative? How will EAB influence your workload when it arrives? To what level do you collaborate with other agencies and organizations to address EAB related issues? What types of businesses or organizations do you feel are necessary to collaborate with to maximize opportunity and minimize stress on your operation? Techniques including structured interviews (state level managers, Appendix A) and a survey tool (Appendix D) were used to collect this information from respondents in fall 2011 through spring 2012.

The chief research goal was to gain an understanding of how high level state managers and lower level local stakeholders are preparing to manage and collaborate to address concerns related to the Emerald Ash Borer. The resulting information will help natural resource managers plan and implement strategies that maximize stakeholder engagement and minimize damages associated with the pest.

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Explanation of thesis format

Chapters 2 and 3, which will upon review be submitted to scientific journals, compose the majority of this thesis. In addition, there are general introduction and general summary chapters to provide a general overview for and summary of the two middle chapters.

CHAPTER II

EVALUATING AND BUILDING ADAPTIVE CAPACITY TO ADDRESS
INVASIVE TREE PESTS IN IOWA

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Abstract

Our research surveyed over 100 individual businesses and public sector entities in 3 case study communities in eastern Iowa: Dubuque, Iowa City, and Burlington. The survey aimed to describe thoughts and perspectives on EAB of those individuals who handle tree management and end use of woody material in the public and private sectors of each community. We collected and analyzed information on EAB threat levels and perceived impact, present and future business adaptations, qualitative impacts to business, and also conducted an SNA (Social Network Analysis) of each community's entire wood utilization sector to better understand the relationships between actors and how the communities and business groups compare on various SNA metrics (centrality, heterogeneity, density, etc.) We also characterized the nature of the 'wood utilization sector' in each community to better understand how these businesses and city government entities process trees from inventories and removal to eventual end-use and

replanting. From this information, we created a new metric to measure an individual business' propensity to adapt to EAB and from there characterize the general readiness of the communities. We found that businesses in the private sector are by and large less prepared to adapt to invasive pests and therefore deal with the local fallout from EAB including a large influx of often low-value woody material. The communities also varied in their reaction to the threat of EAB and also their level of response in terms of business strategies, showing wide ranging adaptability based on varying metrics (size, sector, age, EAB threat perception etc.). The SNA revealed that some business entities are connected only through specific brokers to the city government which will limit information sharing and contract work as EAB moves further into eastern Iowa.

Introduction

Emerald Ash Borer

Human "quality of life" is strongly connected to the environmental amenities in the communities where people live and a communities' green infrastructure plays a defining role in these amenities (Nowak and Dwyer, 2007; McGranahan et al., 2005; Benedict and McMahon, 2002). Urban forests are a critical component of green infrastructure as they provide and/or mediate a host of privately and publically experienced environmental, economic, and community services. These services range from beneficial ecological dynamics such as nutrient cycling, pollution mitigation and wildlife habitat as well as more socially defined benefits such as

mediating urban aesthetics, enhancing real estate value, supporting community identity, and generally improving human physical and mental health (Peterson and Straka, 2012; Nowak and Dwyer, 2007). Today, the impact from a relatively new introduced pest, the Emerald Ash Borer (EAB; *Agrilus planipennis*) has the potential to exceed the extensive damage of any pest or pathogen previously encountered in North America, threatening the services provided by urban forests. The Emerald Ash Borer is an introduced coleopteran species suspected to have arrived in the US on solid wood packing material from Asia in the late 1990's. The beetle lays eggs on the bark of *Fraxinus* species after which larvae burrow into the bark in order to feed on the sap within the phloem of the tree, cutting off the transportation of essential nutrients and water from the roots to the leaves and ultimately killing the tree (Liu et al., 2007; Liu et al., 2003). Containing the movement of EAB has been challenging due to the capacity of the Emerald ash borer itself to travel as well as the fact that EAB is frequently moved via firewood, nursery stock and log transportation (Petrice and Haack, 2007; Bauer et al., 2004; Taylor et al., 2006). The variety of methods and the ease by which EAB can be transported deems that the risk for rapid spread is quite large, and the pest has covered over 500 miles in at least one direction from its original infestation site in south-eastern Michigan, an average rate of approximately 50 miles per year.

From a socio-economic standpoint, the context for significant costs is multifold and dynamic. In natural forests, Midwest region estimates of lost stumpage value due to lost growth potential, diminished wood quality and material de-valuation caused by market saturation put economic loss beyond $100 billion (Federal register, 2003; Goebel et al., 2010). In natural forest conditions, rapid ash mortality also leads to complex and potentially negative ecological outcomes in terms of forest structure and biodiversity (e.g., Pautasso et al., 2013; Gandhi et al.,

2010; Herms et al., 2009). This is particularly concerning in environmentally sensitive areas such as riparian corridors (Pautasso et al., 2013). In urban contexts, costs involve tree removal, material disposal, replanting and other remedial work, as well as lost ecosystem service value (McKenney and Pedlar, 2012; Poland and McCullough, 2006).

EAB in Iowa

Contextualizing the potential impact of EAB in Iowa, the Iowa Department of Natural Resources (IDNR) estimates that 15-20% of all trees in Iowa communities (i.e., within city limits) are green ash (*Fraxinus pennsylvanica*). In total, Iowa has roughly 30 million *Fraxinus* street trees (IDALS, 2013). In addition, outside of urban areas in Iowa it has been estimated there are over 50 million ash trees (mixed *Fraxinus* sp.; white, green and black) in bottomland and upland forests (IDALS, 2013).

The overall economic impact from removal and disposal of a large portion of the urban tree canopy in Iowa is expected to be substantial. The Iowa DNR (2013) has estimated a lower bound cost of EAB in urban contexts at around $2.56 billion (which includes removal costs, tree replacement costs and lost amenity value). Yet, in another study of compensatory values for the overall economic significance of urban trees accounting for tree size, species type, condition, and location, the value for Iowa ash trees was estimated to be $ 3.3-8.3 billion dollars for the urban canopy alone (Nowak et al., 2002). These costs will be distributed across public agencies and private homeowners who will need to remove and dispose of trees on their respective properties. The lost amenity value is of particular concern in Iowa, as the majority (60% +) of the farm and non-farm population live in rural towns and larger cities where treed and other natural areas are already at risk from farmland and urban development (Bowman et al., 2012).

Simply put, the Iowa DNR projects that "EAB has more potential for future harm to Iowa forests and urban communities than any other insect currently being dealt with in the United States" (Flickinger 2010, p. 125). Furthermore, current and future issues with invasive shrubs, pathogens, and non-native pests, including the European Gypsy Moth (*Lymantria dispar*), Thousand Cankers Disease (*Geosmithia morbid*), Bur Oak Blight (*Tubakia* spp.), the Pine Shoot Beetle (*Tomicus piniperda*), and oak wilt (*Ceratocystic fagacearum*), among others (see Flickinger 2010), in combination with EAB, will put continued stress on Iowa's forest resources and place greater emphasis on the need for active forest management through strategic planning (Flickinger, 2010). Most small communities in Iowa have limited expertise, personnel and budget devoted to address tree maintenance, removal, and replacement (E. Bruemmer, IDNR State Urban Forester, personal communication). Without outside assistance and collaboration, the response efforts of these small communities are severely limited.

Adaptive capacity

The capacity of small and large cities in Iowa to efficiently and effectively respond to EAB infestation relies, in part, on mechanisms that encourage learning and adaptation. Furthermore, the ability of stakeholders to initiate or otherwise capitalize on innovative and/or cooperative waste utilization efforts and new markets will strongly influence overall mitigative efforts (Bradshaw et al., 2012). Broadly, the process of building adaptive capacity is "one by which groups of people add new and improved methods of coping with the environment to their cultural repertoire", and this process has allowed cultures (and communities) to survive through environmental stresses, and to overcome them (Smit and Wandel, 2006; O'Brien and Holland, 1992) Local adaptive capacity is often linked to broader conditions, manifesting as the presence of institutions and social networks that learn and store knowledge and experiences, create

flexibility in problem solving and balance power among interest groups (Scheffer et al., 2001; Berkes et al., 2003; Armitage 2005).

Social networks

Community action, with respect to natural resource management, is influenced by a combination of factors, including the biophysical and socioeconomic context, a shared community perception of risk, and importantly, the interactional capacity of stakeholders to work together on issues (Pretty, 2003; Flint and Luloff, 2007; Flint, 2008). Thus, the ability of those within communities and among communities to coordinate and collaborate is seen as a critical antecedent to action. These collaborative relationships, i.e., social networks, are widely found to be important by facilitating the acquisition of knowledge in various systems (Bodin et al., 2006).

Networks can also aid in the gathering of resources in governing situations (Newman and Dale, 2007). In addition, networks can help with conflict resolution and their precise structure can have a profound effect on how individual stakeholders behave within the network (Hahn et al., 2006; Wasserman and Faust, 1994). However, building "effective" stakeholder networks is not as simple as it may appear; as Newman and Dale (2005) note, "not all social networks are created equal," where the structure (e.g., the strength of relationships, level of connections to those with diverse information) can facilitate or even impede the exchange of resources, such as knowledge, among individuals, and ultimately influence natural resource decision-making (Bodin et al., 2006, Crona and Bodin, 2006; Janssen et al., 2006; Bodin and Crona, 2008) and the outcomes of these decisions. Hence, examining a stakeholder network can illustrate the complex nature of the relationships between various entities, and can depict how features of a network may obstruct governing processes (Bodin and Crona, 2009) and can identify opportunities and

obstacles to successful natural resource management (Bodin et al., 2006). Network analysis has

been used prevalently in assessing issues of natural resource concern, and recent studies give us

insight of their importance in problem solving (Bodin and Crona, 2009). Environmental issues

on the local scale are ripe with opportunities for effective network use, and make full use of the

strategy by using the data to understand the characteristics that increase the likelihood of

collective action which leads to proactive natural resource management (Tomkins and Adger

2004).

Research objectives

The first main research objective of our three-city case study is to broadly characterize

the EAB "readiness" of both public and private stakeholders who will be expected to take on

direct and indirect supervisory and/or physical EAB remediation responsibilities in our case

study region. As guided by the experiences of other Midwestern states in responding to EAB

(e.g., Michigan, Ohio, Illinois), the stakeholders of interest in our study are: 1) those who

manage public trees directly or who administer urban forest policy (e.g., city forest or park

personnel, state-level foresters); 2) private companies such as tree services, nurseries and

landscapers who sell and or plant nursery stock; 3) potential material end-users such as primary

or secondary wood processors and entities in the energy and waste sectors; and 4) any non-

governmental organizations who involve themselves with urban tree issues. Our second research

objective is to use Social Network Analysis to assess the structure of the relationships between

and among these stakeholders so as to better understand: who the key entities are and to better

understand the division of responsibility between public and private entities. Such info will

elucidate the business and public agency collaborations that form the basis of EAB response and

assess the degree to which private entities will be relied upon in what is largely a public policy

situation. The results of our multi-stakeholder EAB social network analysis will be used to help:

- Determine the state of "readiness" of Iowa communities

- Identify the spectrum of individuals, organizations, and entities that are likely to play central roles (directly or indirectly) in both EAB readiness and response.

- Raise awareness of and reflection on the importance of informal networks and ways to enhance their organizational performance.

- Discover ways to innovate and improve learning among all stakeholders.

Identifying the perception of EAB by the most direct action-oriented stakeholders may lead to insights to how resources can best be allocated and how communication with these businesses should be directed. This will allow natural resource managers to assess the potential threat level in cities and small communities and best allocate resources to wood removal efforts and otherwise meeting the needs of Iowa communities. Our study provides a novel approach to understanding elements of adaptive capacity in the context of an invasive pest species in the Midwest, and includes defining the current state of a network of private and public entities as related to current and anticipated adaptive responses and their patterns of communication and collaboration.

Methods

Case study communities

In order to characterize the adaptive capacity of urban centers in Iowa to respond to the emerging EAB threat and to determine the extent to which communities in Iowa are prepared and preparing for EAB, we selected three of the largest Eastern Iowa population centers set on

the forefront of the western edge of the EAB infestation to serve as case studies. The selected communities shown include two metropolitan areas, Iowa City (pop. 67,862) and Dubuque (pop. 57,637), along with a mid-sized city Burlington (pop. 25,663) (US Census Bureau 2011). The approximate location of these cities relative to one another and to the EAB infestation front suggests that cities throughout Iowa may learn from the insights gained through the perspectives of key urban tree stakeholders regarding how EAB has or is expected to impact their business or duties. At the time of the survey each city was no more than 75 miles from a known Emerald Ash borer population, with Burlington and Dubuque sitting directly across the Mississippi River from quarantined areas in the eastern border state of Illinois (USDA/APHIS/PPQ, 2012).

Respondents in our categories were initially selected if they were employed within 20 miles of each of the three surveyed communities and at least part of their business took place within city limits. We aimed to get a complete picture of the wood utilization sector, and compiled contact lists for each community from online databases. To accommodate businesses that weren't online, we sent an "in-progress" contact list to the city forester of each community to check for businesses that we had missed. The contact list for the network portion of the survey was sent to the city foresters of each target city beforehand to verify accuracy of our list. The main technique used for this assessment was a structured interview in survey form with social network data collection also embedded within the survey. In addition, some qualitative data was collected through an open ended survey question. The survey was administered using a mixed-mode Tailored Design Method approach (Dillman, 2006), using both mailed and phone oriented surveys to increase the overall response rate and to explore a more complete social network from each community (Dillman, 2008). An initial mailing of the survey was followed by a reminder postcard sent a week later. A second mailing was delivered two weeks after the first

and phone surveys commenced 2-4 weeks after the second mailing to non-respondents. From our initial list, we cut off our surveys after effectively exhausting our response groups with 2 mailed surveys (reminder prompts for each) and 10 phone calls to each stakeholder. The survey was designed through an iterative process over the course of 6 months, and surveys were tested with individuals in the wood industry, foresters from the state, and natural resource professionals involved in managing the spread of EAB in other states, to determine appropriateness of questions. Institutional Review Board protocols were followed. The survey was initiated in January 2012.

The survey consisted of Likert scaled questions, questions with pre-determined response selections and probing open-ended questions. With regard to the SNA component, we specifically asked each stakeholder to identify who they interact with and we used a "roster" of known entities with respondents encouraged to write in additional network ties. A roster is a list with all known entities listed by name; rosters are commonly used in SNA research to help with respondent recall as they attempt to exhaustively list entities in their network (Butts, 2008). This information allowed us to calculate various network metrics such as an individual's heterogeneity and centrality and helped us learn about their general position in the network. Respondents then ranked their top five most important stakeholders in relation to their own work. Assuming EAB will become more widespread, respondents were asked which types of stakeholder they expect to collaborate with which they currently do not. Finally, respondents were asked whom they looked to as 1) "leaders" and 2) "innovators" in tree management and wood utilization in their communities. Survey data was analyzed using IBM SPSS 21.0; Social Network data was analyzed primarily using UCINET 6.476 for Windows and Netdraw 2.119 (Borgatti et al., 2002).

Results

To address our research objectives we assessed expected EAB detection, given stakeholder roles in urban tree management. We also evaluated how stakeholders perceive EAB impact (positively, negatively, or both). Given a business' perspectives on EAB, we then sought to characterize the amount and type of adaptations that stakeholders have already adopted and are preparing to undertake in the future. Lastly, we evaluated the composition of current and anticipated new business relationships through an assessment of current network metrics, comparing public and private entities and evaluating the ways that they may prepare differently for EAB.

1. Timing of detection and anticipated impact

Variability is noted both between business categories and between public and private entities with regard to views regarding expected EAB arrival. The majority of stakeholders (47% overall) expect that EAB is either already present in their community or will be identified within the next 1-5 years (Table 1). Anticipated timing of detection appeared to vary by business type; however, some businesses were not as well represented in our survey and therefore we were unable to assess if proportions of those responded varied significantly A small percentage of respondents believe that EAB will be an issue in their community within 5-10 years from now and these include individuals largely representing tree services (Table 1). Interestingly, slightly over a quarter of all respondents were unsure when EAB may be detected in their community.

Perceived impact

Also of interest is how the various stakeholders qualitatively perceive what the overall impact of EAB will be to their business (e.g., positive, negative, or positive and negative impact) and how general job responsibilities might change. Overall, the majority of tree services and nurseries surveyed expect that the impact to their business/work due to EAB will have both positive and negative qualities (Table 1). On the positive side, EAB may be perceived as expanding business opportunities in the short term to medium term, with new business contacts being formed as EAB moves into these cities, as was shared in open-ended responses to this question. For example, one tree service stated that they would experience a welcomed increase in workload due to the large ash component in the community, and they have been receiving more requests to proactively cut down ash and plant trees. Several tree services will be able to take advantage of secondary markets for firewood, which will be a positive for business.

However, the impact of EAB was also described as negative (by 37% and 38% of tree services and nurseries respectively). One tree service mentioned that they already had all the work they could handle, and couldn't take on any additional responsibilities. Twenty percent of stakeholders (including a large portion of the Primary Wood Byproducts, Sawmill, Lumber Companies, and the majority of City Government and Forester stakeholder groups) who are either responsible for disposal issues or processing ash wood indicated that EAB has already created obstacles in their operations, such as limiting jobs they could take on because of wood transportation quarantines, as shared through our open-ended question; Dubuque and Burlington are located on the eastern border shared between Iowa and Illinois, and often work back and forth on both sides of the river. This is reflected in the majority (56 and 69 percent) of city government and wood processors who view EAB impact as primarily negative. Additionally, one

tree service manager remarked that he isn't currently familiar with the standards and rules that he would have to adopt to comply, mainly with rules that apply to transport, suggesting that changes would negatively affect his business due to compliance issues.

A small number of stakeholders emphasized both the positive and negative on the issue of EAB. For example, one urban forester remarked that time will be an negative obstacle due to the need to remove urban dead or dying trees quickly in the short term, but they also believe that EAB will spur public awareness to issues surrounding the importance of urban trees and tree management, which could improve their relationships and interactions with the public and could help avoid or mitigate future problems that could be human caused (e.g., moving infected/infested firewood). Importantly, over 90% of tree services and 50% of tree nurseries and landscapers envision a significant increase in overall workloads due to EAB. Most respondents who believe that EAB will be in their community sometime in the next 10 years, anticipate that EAB will impact their workloads (61% overall).

2. EAB-centered adaptations

Current adaptations

In addition to stakeholder perceptions and attitudes towards the spread of EAB, we were also interested in understanding stakeholder current and anticipated behavior (in the next 1-5 years) related to EAB. The top three actions that have already been adopted include changing standards or rules, training employees and implementing new communications and marketing strategies (adoption rates of 26%, 20%, and 11%, respectively), whereas the other adaptations have been adopted by relatively few stakeholders (Table 2).

We gained further insights into the types of standards and rules that may be applied in the future through our open-ended responses and informal discussions with stakeholders. We found that these changes to standards and rules may vary in complexity and likely include the direct handling of wood material (processing and transportation) and/or dealing with chemical treatment protocols and in guiding management priorities (e.g., whole-scale proactive ash tree removal and replanting, or treatment management for specimen trees that may be of higher value to property owners). For example, one city forester noted that they have been assigned to design a city-wide policy for EAB. The city has also looked at workforce adjustments (new training, increase in seasonal employees) to handle increased workloads. Another city staff member remarked the city is dramatically changing the way they evaluate and manage their street tree inventories. For example, they are considering shifting replanting efforts to citizens by encouraging more private yard tree planting as opposed to city-street tree planting. Other changes in standards or rules were described by tree nurseries as well. For example, in all cases, we found that the tree nurseries who were surveyed reported that they have stopped selling ash trees, and instead are recommending a variety of other hardy street trees instead (e.g., *acer sp.*, *quercus sp.*, *carya sp.*, *celtis occidentalis*). We noted the relationship between some of the current and anticipated actions through the open-ended responses as well. For example, one city forester noted that as they are considering changing replanting standards, they additionally need a concomitant communications/outreach campaign that stresses the importance of enhancing urban tree species diversity and is directed towards city personnel, businesses, and private citizens.

Training of employees to address EAB was also referenced most frequently by stakeholders; roughly 1 in 5 stakeholders have already implemented training; however the

percentage of those already involved in training varied across businesses (Table 2). For example, all of the city foresters that we surveyed stated that they have trained their staff with regard to EAB. We found through the open-ended questions that city forestry staff are often asked to develop new management plans that incorporate removal of ash trees in a timely manner, in addition to coordinate replanting to replace the lost urban tree canopy. With respect to other actions, currently, only a small portion (< 10%) of stakeholders surveyed have made changes to their operations in terms of capital investments, entering a secondary market, or increasing permanent or seasonal employees to address the spread of EAB (Table 2); of those who have made investments, city government has pursued capital investment and hired part time employees, and wood producers sector have taken steps to enter a secondary market.

Expected adaptations

We found that that EAB is expected to instigate a number of specific actions much more broadly across the whole range of listed adaptations over the next 5 years (Table 2). Nearly half of surveyed stakeholders will continue to implement new employee training; which involves the majority of primary wood, sawmill and lumber companies. For those responsible for tree removal and cleanup, this may entail training new and existing employees to work with the range of chemical applications and new management techniques for addressing EAB infested trees. For example, around a quarter of businesses expect to hire new employees either seasonal or permanent (Table 2). Hand in hand with this training, 41% expect to be adjusting to changes in standards and rules that will affect their business. In reality this number may be far higher judging by the all-encompassing nature of compliance regulations in other states, some businesses simply won't be able to avoid compliance regulations (personal communications,

member of Iowa's EAB Task Force. For those on the wood utilization chain, changes in standards and rules may affect the way they collect, transport, and store woody materials.

Not only did we find an anticipated influx of new employees into the tree management and wood utilization sector, over a third of stakeholders noted an anticipated shift in the roles and duties of current employees. In addition, stakeholders expect to invest in their business through capital investment or hiring new permanent employees (34% and 21% respectively). This may relate to expansion into new markets and thus work responsibilities; 20% of stakeholders are looking to expand into a secondary market. Moreover, businesses anticipate seeking support in the form of grants and loans which may help support expansion into these new markets, which may allow businesses to start processing some of their own wood, whether it is for hardwood lumber, firewood, livestock bedding, woodchips, or other end-uses. For example, one tree service mentioned that they may devote more energy to selling firewood locally due to the increased wood from removals. New investments may play an important role in building business capacity to adapt, with stakeholders looking to purchase new equipment (e.g., wood chippers, tub grinders, additional dump trucks, etc.) or otherwise expand their operation by acquiring access to new dump or storage sites for wood waste.

In order to better determine the degree to which local businesses are planning to adapt to the situation created by EAB, we created an "adaptation index" by summing present and future adaptations. The index allows us to differentiate between different businesses and areas of wood industry in terms of their capacity to address EAB as measured by a combination of prior and anticipated involvement in the list of adaptation strategies.

3. EAB affected social networks – public/private relationships

Given the anticipated detection of EAB in the next 5 years, it is apparent that businesses and city entities will be looking to form new ties with businesses to likely share workload or otherwise collaborate for mutual benefit of both parties. We found that new collaborations are expected to be formed by over half of stakeholders across most business types. Interestingly, many businesses and organizations (46%) expect to collaborate with businesses or city personnel in other communities in the future (Table 2). This includes partnerships between businesses, between city staff and businesses, and between neighboring cities. The bulk of collaborations are heavily centered in those businesses and organizations that will deal with tree removal and initial material handling (e.g., waste and/ or a secondary product such as mulch). We found that tree services were nominated by 44% of survey respondents, and local government was nominated by 38% of respondents as likely future collaborators (see table 3). One third of respondents nominated either a City or DNR Forester as a likely collaborator on an EAB issue. The necessity of beginning to remove affected trees in a timely manner dictates that these tree managers may be valuable first collaborators when dealing with local infestations.

Wood utilizers such as sawmills and lumber companies (nominated by 30% of respondents), firewood dealers (nominated by 20% of respondents), and primary wood processors (nominated by 17% of respondents) may be looked to for efficient and/or novel ways to dispose of ash materials so as to reduce costs of landfilling or producing a usable end product. Power facilities will potentially play a key role in using wood waste for power generation as many can retrofit coal boilers to utilize a pelletized dry-wood byproduct that can be produced from the removal of urban trees. For example, one city facilities manager talked about his efforts to begin feasibility testing with boilers retrofitted to burn wood pellets in the near future. We also

see businesses looking beyond tree removal and material handling to replanting efforts (tree

nurseries, volunteer organizations), and 33% of surveyed stakeholders expect to collaborate

directly with tree nurseries.

Public versus private nature of networks

The public sector is largely made up of city government, but includes waste and energy

services. On the private side, tree services and nurseries make up the largest portion, with

sawmills, private wood industry, and landscapers making up the remainder. The public sector

(n=15) has much higher adoption potential for new adaptation strategies (avg. = 7, see table 5

below), while the private sector (n=45), has just over half that adoption potential (avg. # = 3.9).

As one might expect, on average the types of strategies also differ between the two groups. This

illustrates the point made above, that the roles of the two groups are plausibly quite different

from one another. The public sector is planning to adapt to deal with the pest at a greater rate

than the private sector due to their role of taking care of city affairs. The private sector is less

concerned with adaptation, and one might surmise that this because they are not pressed to take

on more work when EAB arrives in the same way that city personnel are.

After the overall assessment of network structure and stakeholder breakdown, we did

some further analysis to gain insights into the nature of the public-private relationship in these

communities. The adaptation metric from above is included as well as some basic SNA metrics

to get an overall picture of systemic differences in these groups that often work side by side yet

may have vastly differing roles.

In our networks, the public stakeholders are predominantly in the core of each network,

whereas private stakeholders generally are more peripheral. This dichotomy is interesting to

break down using specific network metrics. The public sector entities have more in-ties on average than the private sector (stakeholders nominated them as someone that they interact with more frequently), indicating that this group or more often sought after for collaboration or information than the private sector. In table 5 above, we conducted a t-test to verify any differences between public and private stakeholders on various metrics (see table 4). The public sector has completed more unique adaptations towards EAB than the private sector, by almost double. However, the current leadership has been in place for longer on average with private sector businesses. Public sector entities are on average better connected than the private sector, with an average of nearly 7.5 in-ties to the private sectors 4.29 (see table 4). This means that the public sector is better connected, again with nearly double the network connectivity of the private sector. We see that both public and private stakeholders expected to encounter EAB in their respective lines of work within about 2 years from the date of the survey, and EAB will impact both sectors in a predominantly negative way.

Discussion

Dichotomous perceptions

Given the different make-up of the public and private sector groups, we expected there to be a significant difference in the overall risk perception and therefore total number of adaptations that each were willing to undertake. This difference is expected in part because of differing accountabilities and therefore perceptions of responsibilities. Public employees must meet and overcome obstacles on a regular basis to keep their organizations and city operations running smoothly. On the private side, businesses may be less likely to adopt new adaptation strategies

due to a desire to maintain business as usual (a wish to limit their business size and scope of work), the owner may be close to retirement, or they may not see an impending pest risk as a reason to adopt new business strategies.

The overall top three adaptations are the same for both public and private entities. These adaptations are also likely easiest to implement in terms of resources required. Changing standards and rules within a business and providing additional training to employees can often be facilitated within the context of the current structure of the business without the need for much if any, external input or infrastructural investment. Based on various responses to the survey, the formation of new collaborations is an ongoing process (although not all entities plan to form new collaborations). Due to the differences in the average number of adaptations for public and private groups, the overall implementation for practices is higher across the board for public entities (avg. + 28%) with several adaptations being over twice as likely to occur within the public sector than the private sector.

Those adaptations more than twice as likely to occur within the public sector were the changing of employee roles and duties and the prevalence of seeking out grants or business loans to help with fallout from EAB. This became quite apparent when speaking with city officials in the survey communities during our workshops. One city worker mentioned that he is running a smaller forestry crew than is necessary to complete all of his work at the present time. With what we have seen in other states, an understaffed forestry division will become woefully inadequate once the pest hits within city jurisdiction. These two adaptions make good sense in this light. Employees will likely be redirected into different forestry roles such as tree removal, and managers will be seeking whatever help they can get via new loans and grants (equipment, funds to hire new personnel etc.).

Several other adaptations appeared with much greater frequency (at least 85% more likely in public over private). These strategies included creating new collaborations of any sort (both within the same city and between and amongst other cities) and the development of new marketing or communication strategies. Although the development of new marketing and communication strategies may seem like more of a private sector adaptation, new communication strategies will greatly increase public knowledge of EAB and tree management and therefore help citizens to better understand and prepare for EAB. In addition, the city will most likely spend more time in contact with individual homeowners who are curious and or concerned about EAB once the pest gets closer. Our target communities may realize this and see new proactive forms of communication as a good way to target homeowners and potentially make the situation more straightforward for everyone involved. Cities will likely also be overwhelmed with the sheer amount of trees that must be removed. This is indicated by the difference between public and private when it comes to new business collaborations. Tree services may be able to take just the work that they can handle, but city forestry staff cannot. They will be contracting with local tree services and likely with businesses in nearby cities as well as cities themselves for equipment and personnel sharing. The private sector (whose frequency for new in-city collaborations is 38% compared to the cities 73%) may not yet realize the degree to which they will be key players in dealing with EAB.

Every single adaptation had a higher occurrence in the public sector, and this can be contributed to a number of factors, some of which are mentioned above. Some tree services (a large part of the private tree management sector) already have all the business they wish to handle, and may therefore not see another pest as a business opportunity. These businesses may not be seeking to expand or adapt in as many ways specifically due to EAB. Instead, adaptations

they make will not be tied to the pest but other factors such as the expansion of the city or the change in the number of similar businesses in the community. For example, some tree service managers noted the disappearance of longstanding tree management companies in the area, which would free up customer base and allow them to expand into new areas of the market.

Overall, we see well over half of the "front line" entities (city gov't, tree services) being not only willing to adapt but planning to. As the pest gets closer to Iowa communities, we expect to see not only more adaptation from those entities who are already adapting but also stakeholders that will follow suit once they see the crisis to be averted and the potential to expand their own business. These differences between the public and private sector illustrate the need for ample communication between these two groups. Given that all business and city entities will be useful in mitigating EAB impact on a community, it is in manager's best interests to collaborate with a variety of stakeholders from each group. This will help to ensure that negative effects are diminished during a local infestation.

New collaborations

Due to the large amount of new collaborations expected across most stakeholder groups in our survey, it is clear that existing networks are seen as inadequate to effectively deal with a pest disturbance of this size and form and that the adaptive capacity of these cities will be enhanced as new collaborations take place. These new collaborations will take many different forms including sharing of information, contractual work, and equipment and personnel sharing; natural resource managers and community leaders would do well to facilitate these collaborations for maximum damage mitigating effect. For example in the city of Dubuque it was seen that tree services are more peripheral to the network. Managers could make an effort to

more closely collaborate with these entities through workshops or other forms of outreach to ensure a close working relationship when tackling future tree related issues on a large scale.

Through the diversity of networks seen amongst just three communities, and the marked variance amongst businesses and actor groups, it becomes clear that a "one size fits all" state level approach to management will likely be less successful than targeted management. A tailored management approach, taking into account the business make-up of cities and the variance of local business networks is likely to have greater success in terms of preparing cities for EAB. Targeted communication to a few key individuals may go a long ways towards diffusing information through the entire network, as well as facilitating further collaboration between city employees and private sector entities. Managers should also look to facilitate collaborative efforts between the remediation and utilization (tree services and wood products) actor groups to provide an accepted outlet for excess woody materials from tree removals so as to reduce the strain on city waste managers for whom it may be costly to dispose of these materials. From previous discussions with city foresters in Iowa, we know there are already problems with disposal of woody material in urban areas, including illegal dumping and other cost-avoidance practices (Knoot et al., unpublished). Typically, wood from urban trees is chipped and-or whole logs are disposed of by any means necessary. This may mean distributing chips for landscaping, dumping slash at the local waste disposal site (usually for a fee), or stacking logs on the private property of the tree service or city entity performing the removal. Although this may have worked in the past on a small scale, the unprecedented level of waste removal Iowa cities will see beginning in the next 5-10 years, as well as the sensitive nature of the material (businesses will likely deal with one or more quarantines at both the local and state level) will dictate a new approach to urban waste wood management. Those in the wood

products and wood byproducts sectors may not realize that they too could have a role to play, and indeed we heard of very few instances from respondents intending to use ash wood for something other than waste. However, we know from the example of other states who have dealt with wood waste (Illinois for example, [IL Dept. of Ag. 2012]) that there is a niche to be occupied by these industries due to the amount of low quality wood material that could be produced for the firewood, wood chip or animal bedding industries.

Given that we know likely future collaborations (see table 6), we can suggest a targeted management approach. Tree services (44%) and city government (38%) are the two top groups that respondents expect to collaborate with on future EAB issues. In addition, the top group that expects collaboration with tree services is city government, and vice versa. Facilitated communication and association between these stakeholder groups will assist in ensuring ample resources are applied to EAB mitigating efforts in communities. The EAB response team in Iowa, and corresponding teams in other states, can work with community level officials to promote communications amongst these stakeholders in their own cities.

Conclusion

Our study shows that management for invasive pests in these communities cannot be applied in a "one size fits all" fashion. The cities in our study were found to have similar stakeholder groups (mitigation, advisory, etc.) that will deal with tree management and wood utilization but also a vastly different network composition due to the varying ways in which the actors within the networks collaborate on tree management and wood utilization issues. All business and city entities will likely have a role to play in an EAB mitigation or cleanup

situation. The degree to which these individual stakeholders participate (contracts, spread of new EAB knowledge and control techniques, etc.) will depend largely upon existing networks and the degree to which stakeholders are willing and able to collaborate in the future with new entities. With many respondents stating that they expect to collaborate with new stakeholders from various groups on future EAB issues, there is an opportunity for state and local natural resource managers to facilitate these collaborations to aid with mitigation efforts. Key individuals were identified as "leaders" within some stakeholder groups, and these individuals could be contacted directly to spread relevant information in an efficient way. Although a majority of actors in each community are linked to the main network, two of our three case study communities had isolated actors, and effort should be made to communicate with them as these isolated actors may prove to be vital assets for dealing with the EAB conundrum at some point along the chain. The composition of these informal networks is ultimately what will allow for best management on a community-wide scale, and it is advisable that managers are aware of these existing collaborations, as well as the potential for future collaboration in order to foster expedited flow of information, learning, and innovation.

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Tables

Table 1. Expected EAB detection and anticipated response by business type, responses by percent; n=68. 2012 data.

	Public	**Private**			
	City gov't & Waste	Tree service	Nursery & Landscaping	Wood Producers	(n=67)
EAB detection	*(n=14)*	*(n=17)*	*(n=21)*	*(n=15)*	*% Overall*
Already Here	14%	6%	19%	27%	15%
1-5 years	60%	47%	57%	36%	47%
5-10 years	7%	18%	0%	9%	7%
10+ years	14%	6%	0%	0%	4%
Unsure	14%	24%	24%	27%	27%
	100%	*100%*	*100%*	*100%*	
Anticipated impact	*(n=16)*	*(n=19)*	*(n=21)*	*(n=16)*	*(n=72)*
Positive	38%	52%	48%	6%	38%
Negative	56%	38%	38%	69%	49%
Positive and Negative	6%	5%	0%	0%	3%
No Impact	0%	0%	0%	25%	6%
Unsure	0%	5%	14%	0%	5%
	100%	*100%*	*100%*	*100%*	*100%*

Table 2. Percentage of businesses (by stakeholder type) that have already adopted various adaptation strategies related to their business or job responsibilities in response to EAB, and percentage that anticipate adopting the strategies in the future.

| | Already Adopted | | | | | Anticipate Adopting | | | | | |
| | *Public* | *Private* | | | | *Public* | *Private* | | | | Overall Difference (% already adopted - % anticipate adopting) |
Adaptation	City gov't & Waste	Tree service	Nursery & Landscaping	Wood Producers	Overall	City gov't & Waste	Tree service	Nursery & Landscaping	Wood Producers	Overall	
Change standards or rules	29	20	28	27	26%	59	40	33	27	41%	15%
Train employees	41	13	17	0	20%	53	40	44	45	46%	26%
New communications and marketing	24	7	11	0	11%	41	27	39	27	34%	23%
Seek grants/loans	24	0	0	0	7%	41	27	22	27	30%	23%
Change in employee roles or duties	24	0	0	0	7%	53	47	11	18	33%	26%
Enter secondary market	6	0	0	27	7%	29	13	22	9	20%	13%

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Table 2 continued

Collaborate outside city	12	7	0	0	5%	59	47	44	27	46%	41%
Collaborate within city	6	0	6	0	3%	59	40	33	36	43%	40%
Hire new seasonal employees	6	0	0	0	2%	29	40	33	0	28%	26%
Capital investment	6	0	0	0	2%	35	60	28	9	34%	32%
Hire new permanent employees	0	0	0	0	0%	29	40	11	0	21%	21%
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	

Table 3. Expected new collaborations in case study communities (post EAB).

Collaboration	% Respondents intending to Collaborate	Top nominating stakeholder groups
Tree Service/Arborist	44%	City government, Firewood, Nurseries & Landscapers
City Gov't	38%	Tree services, Nurseries
Tree Nursery, Landscaper or Tree farm	33%	Nurseries, Non-profits, City government
Professional forester	33%	Foresters, City government, Nurseries
Sawmill or Lumber co.	30%	Power/energy co's, City government
Firewood dealer	20%	City government, Nurseries
Power or Energy co.	20%	City government
Primary wood processor	17%	City government
Non-profit organization	16%	City government
Waste processor	14%	City government
Secondary wood products	6%	Secondary wood products

Table 4. Variance between public and private stakeholders. For EAB detection, lower is more imminent. For EAB impact, lower is more negative.

Variable	Public		Private			
	Mean	Std. error	Mean	Std. error	t-stat.	P-value
Unique Adaptations	7	.59	3.89	.33	-2.102	.001
Current leadership	21.60yrs	5.76yrs	35.89yrs	3.89yrs	1.358	.066
In-ties	7.47	1.43	4.29	1.16	-1.614	.011
Network connectivity	16.70%	2.00%	9.73%	.80%	-1.625	.010
Heterogeneity	0.47	.044	0.35	.036	-1.331	.316
EAB detection	1.89yrs	.309	2yrs	.105	0.304	.404
EAB impact	-.29	.248	-.12	.199	-2.593	.298

CHAPTER III

STATE-LEVEL MANAGEMENT AND COLLABORATION SURROUNDING EAB, AND IOWA CASE STUDY

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Abstract

The negative impacts from emerald ash borer have the potential to exceed many historical pests and pathogens such as Dutch elm disease and chestnut blight in terms of economic and ecological damage. Our goal was to determine the ways in which policies, programs, and coordinated actions in the context of a formal coalition facilitate collaboration and learning around invasive pest management (specifically EAB) and related land management activities in Iowa. In order to accomplish this, we conducted semi-structured policy interviews with Iowa's EAB Executive Council members, composed of staff from various state and federal natural resource agencies, and carried out a formal social network analysis (SNA) of these core groups and document analysis of the Iowa EAB Readiness Plan

spanning its development over three years. The resulting analysis builds on our

understanding of the ways in which actions between organizations and groups facilitate or

constrain collaboration and learning around disturbance from invasive pests. We found that

learning and collaboration are mainly constrained by variation in regulatory authority and

power differentials among organizations at both the state and federal levels. In addition,

communication and information sharing emerged as points of contention among groups, as

well as conflict and overlap of agency roles. We also examined how department and

organizational roles have evolved over time as EAB moved into north-eastern Iowa; counties

became quarantined and businesses came under compliance agreements. Additionally, we

found that cross-scale networks greatly influenced management decisions, and these

networks will likely prove to be of great importance in determining how EAB is addressed in

the future in Iowa.

Introduction

Managing the spread of invasive, non-native, species at the landscape level is a

challenging prospect for natural resource managers globally (Pimentel et al. 2005; Bradley et

al. 2010). This is especially true given the complexities of invasive species management and

the unpredictable and sporadic nature by which many recent invasive species are spreading,

often aided by human transport (Hulme et al. 2009; Holmes et al. 2009; Pimentel et al. 2005;

Kovacs et al. 2011). With novel invasive species regularly identified, the balance of natural

ecosystems is continually threatened and the costs associated with managing these species

continue to grow (Pimentel et al., 2005; Holmes et al., 2009). In the context of impacts to

forest systems and forest management in the United States, at least 10 species of exotic forest

pests and pathogens seriously affect hardwood tree species in the United States (Orwig,

2002). In fact, the incidence of introduced invasive pests that affect forests has been

expanding due to recent economic globalization (Filip and Morell, 1996; Everett, 2000;

Hulme, 2009), by increasing the number of pathways and rates of invasive species movement

across the globe, and indirectly through such factors as changing land-use patterns and land

disturbances that can provide greater establishment opportunities (Meyerson and Mooney,

2007).

To address the growing concern over and impacts of invasive plants and pests,

research scientists and agencies have recommended and promoted a wide variety of strategies

to understand, respond to, and contain outbreaks at various scales and levels of severity

(Waring and O'Hara, 2005; Anderson, 2005; Chornesky et al., 2005; Meyerson and Mooney,

2007). Organizing and adapting to confront invasive pest issues is likely most effectively

accomplished cooperatively to span the diverse levels of governance, spatial scales, and goals

of partners involved (termed adaptive co-management; Armitage et al., 2007). Co-managing

to approach issues of natural resource concern is widely seen as an effective method of

recourse to deal with pest management as well as other complex natural resource issues such

as responding to fire risk concerns or fisheries management dilemmas that require integration

of policies, practices, and actions that span multiple institutional and spatial scales (Chen et

al., 2012; Gill, 2005; Ratner et al., 2012). Pest detection, spread prevention, and management

are therefore most effective through collaboration that makes use of synthesized on-the-

ground knowledge and regional to global scientific information. This in turn can be used to

develop policies and management approaches that are meaningful to local-scale managers

and regional policy makers. Adaptive co-management systems are thus conceptualized as custom-fit to their specific locales and therefore better suited to develop accurate and informed management decisions based upon the coordinated and cooperative work of numerous organizations with varying responsibilities and expertise (Schultz et al., 2011).

Accessing, building, and mobilizing a cooperative network of partners from a wide spread of disciplines, organizations, and institutions is warranted (Koontz et al., 2004). In fact, any managing body is reliant on collaboration in order to detect, interpret, and respond accurately to feedback from dynamic ecosystems (Folke et al., 2005). Consequently, it is important to build the capacity of the partners responsible for addressing invasive pests so that they may adequately plan for and mitigate damages from pest outbreaks in a collaborative fashion (Armitage, 2005, Folke et al., 2005).

However, there is limited understanding of how current approaches to managing invasive pests and pathogens align with principles of adaptive co-management and elements deemed as essential to effective partnerships and collaboration. The purpose of this research is to examine adaptive management, co-management, and collaboration surrounding an invasive pest (specifically EAB) using a case study focused on Iowa and the process by which state-level managers are approaching pest management at a landscape scale.

Case study – Iowa's coordinated response strategy to the emerald ash borer

The state of Iowa is the most recent jurisdiction to experience arrival of the emerald ash borer (EAB*;* Agrilus planipennis), an introduced coleopteran species suspected to have arrived in the US on solid wood packing material from Asia in the late 1990's (IDNR 2010). This invasive beetle infests and kills trees in the genus *Fraxinus* regardless of species, size or

age class, thus affecting nursery stock as well as mature specimens (Haack et al., 2002). The entire native and cultivated ash resource in North America is considered at risk for mortality due to EAB. Considering that species within the genus are the second most common street trees in the Eastern U.S., EAB is likely to become the most costly urban tree pest in US history, and certainly the most challenging management situation since Dutch elm disease (Federal Register, 2003; Kovacs et al., 2009). For example, the USDA-Animal and Plant Health Inspection Service has estimated that across the US, urban ash tree removal costs alone will range between $20-60 billion (USDA-APHIS 2009). Other costs that are relevant include equally high replacement costs and short-term ecosystem service losses (e.g., Foster et al., 2011; Nowak et al., 2006). Natural forests are not immune to the effects of EAB. From strictly an economic perspective, estimates of the US Midwest region stumpage value that could be lost are potentially close to $100 billion dollars (Federal register, 2003; Goebel et al., 2010).

The first EAB infestation in Iowa was confirmed by the Iowa Department of Natural Resources on May 15, 2010 in the north-eastern corner of Allamakee County on Henderson Island in the Mississippi River (IDNR, 2010). Containing the movement of EAB is very challenging due to the capacity of the emerald ash borer itself to disperse as well as the fact that EAB is most frequently dispersed over distances of many miles by humans transporting firewood, nursery stock or logs (Petrice and Haack, 2007). The Iowa Department of Natural Resources (IDNR) estimates that 15-20% of all trees within city limits in Iowa communities are green ash. Outside of urban areas, it has been estimated that there are over 50 million ash trees (mixed *Fraxinus* sp.; white, green, black, etc.) in bottomland and upland forests statewide (IA Readiness Plan, 2013).

In regions previously impacted by EAB (the US Midwest and Canada)[1], the effects of mitigation has been a challenge in the context of city and state budget limitations. The Iowa DNR projects that "EAB has more potential for future harm to Iowa forests and urban communities than any other insect currently being dealt with in the United States" (Flickinger, 2010, p. 125). Economic impacts from removal and disposal of a large portion of the urban tree canopy in Iowa are likely to be significant. The Iowa DNR (2013) has estimated a lower bound cost of EAB in urban contexts at around $2.56 billion (which includes removal and tree replacement costs, as well as lost amenity value). The ability to absorb these costs is uneven, with many small communities less likely to dedicate municipal budget resources to address immediate needs for tree removal and replacement (E. Bruemmer, IDNR State Urban Forester, personal communication).

Iowa's evolving response to EAB

As part of an evolving pest management approach specific to EAB, the state of Iowa established both a multi-agency leadership group as well as what has become known as the State's EAB Readiness Plan. Iowa's EAB Readiness Plan readily reflects the acknowledged importance of building partnerships that can aid in effective communication and response. Prior to the development of the Readiness Plan, the Iowa Forest Insect & Disease Management Council has been working to prevent EAB introduction to Iowa since 2004 with monitoring including visual surveys and placement of "trap trees" (dying *Fraxinus* trees

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[1] EAB has since become more than a local or regional issue, with infestations now well established in Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Missouri, Ohio, Pennsylvania, Virginia, West Virginia, and Wisconsin as well as Canada (Ontario and Quebec) (see: www.emeraldashborer.info for a periodically updated map of EAB spread) *(USDA/APHIS/PPQ 2012)*.

marked for EAB monitoring). It wasn't until 2010 however, when EAB was confirmed in state, that Iowa formally delineated a plan of action towards EAB.

Specifically, Iowa has assembled a team of technical and communication specialists to facilitate ongoing response to EAB movement on a case-by-case basis.. As part of the overall strategy, which attends to effective communication, a statewide 'slow the spread' movement aims to educate businesses and citizens about the dangers of moving firewood that may be potentially infested with EAB adults or larvae. Also, the Iowa EAB Readiness Plan, which is updated periodically by the team and conceived of as a dynamic document, reflects the overall and evolving goals of Iowa's response strategy, calls for a variety of approaches to help prepare for and mitigate damages from EAB in Iowa including: 1) facilitated communicate between public and industry professionals; 2) take proactive steps to speed administrative processes by helping communities identify economically viable methods for removing declining ash trees and examine their administrative processes for streamlining opportunities; 3) develop and investigate the implementation of a reforestation program; and 4) explore wood waste utilization opportunities in local or regional markets to reclaim ash material to its highest possible use. These actions help to define a proactive approach to pest management, with the goal of preventing damages from becoming overwhelming.

From adaptive management to collaborative management

While concepts such as adaptive management, co-management, and adaptive governance include several of the elements already reflected in Iowa's approach to EAB, building effective partnerships can be complex and does not always ensure beneficial

outcomes. Therefore further attention to principles of adaptive co-management and effective network collaboration, relatively new concepts in natural resource management, is warranted as we look to such principles to assess current state's collaborative approach to addressing the spread of EAB.

Adaptive management by definition involves learning; however, the importance of social processes, participation, and social learning through involvement by multiple stakeholders and decision-makers has been further emphasized over time, resulting in the incorporation of adaptive governance and co-management concepts. Adaptive governance and co-management involve social learning amongst scientists, politicians, and other local actors to combine both scientific and non-scientific knowledge on a quest towards sustainable management (Folke et al., 2005; Rist et al., 2007), while policies and proposed management actions are treated as experiments that facilitate learning (Folke et al., 2005). Adaptive capacity is widely seen as the ability of a group of individuals, communities, or organizations involved in a collaboration to effectively respond to a threat such as invasive pests. This manifests as the presence of institutions and networks that learn and store knowledge and experiences, create flexibility in problem solving and balance power among interest groups (Scheffer et al., 2002; Berkes et al., 2002; Armitage, 2005). In order to build collaborative capacity, it is of utmost importance for all individuals involved having a mutual understanding of events and potential outcomes through shared learning (Daniels and Walker, 2001). This is accomplished through creation and maintenance of networks through which important natural resource information is communicated on a regular basis.

Natural resource collaborations and co-management arrangements are often difficult and conflict among those involved can be a frequent occurrence (Armitage et al., 2009);

moreover, not all collaborative arrangements can result in beneficial outcomes. Consequently, a recent emphasis on understanding the pattern of social relations (i.e., social networks) has emerged to address issues of natural resource concern, and recent studies give us insight of their importance related to understanding adaptive capacity (Bodin and Crona, 2009). For example, an understanding of network structure and function helps us to better understand power relations, the exchange of resources, and communication patterns that can hinder or promote learning and successful natural resource management outcomes (Isaac et al., 2007). By describing and depicting networks, one can better understand the "story" and pattern of individuals working together to address issues given that these social relations aren't under the purview of one person or agency but rather fluid and somewhat nebulous. In fact, SNA has been used effectively to build on qualitative understanding in a variety of areas including the education, family studies, and health care fields (Martinez et al., 2003; Tolsdorf, 1976; Sibbald et al., 2013). However, examples of empirical evaluations of existing social networks and assessments of adaptive capacity in the context of natural resource management, particularly in invasive species management, are limited (Klenk et al., 2009; Ranco et al., 2012).

Objectives

Our goal was to determine the ways in which policies, programs, and coordinated actions facilitate collaboration and learning around invasive pest management (specifically EAB) and related land management activities in a state in the United States, Iowa, in which EAB has only recently been confirmed. The primary objective was to evaluate the current capacity of state policies and programs to influence successful collaboration surrounding

EAB and tree management and to capture economic opportunities, which included four main tasks.

1. Document evaluation of the EAB Readiness Plan

2. Assessment of the composition and network structure of the EAB team

3. Evaluation of roles and responsibilities of EAB team members, their relationships, power differentials and associated challenges,

4. Analysis of anticipated role changes as EAB moves into the state of Iowa

Assessing the composition of the readiness plan and relationships of the EAB team will help us to determine the extent to which they facilitate or constrain collaboration and allow us to gain insight to how response can be enhanced and communications improved. This will be useful to natural resource managers as they proceed with damage mitigating efforts leading up to and during EAB infestations and address other threats as well that demand a coordinated and collaborative approach. We will also assess the nature of the adaptive management strategies taken by the state of Iowa, as well as the implications of assembling a team of specialists from various disciplines to form new policy. We examine how learning is taking place within this group, and how that translates into various on-the-ground management activities. Finally, we discuss potential improvements that could be made to the adaptive model, and how other states and collaborative efforts can learn from Iowa's situation.

Methods

Our methodology includes a combination of document analysis, in-depth interviews, and a structured social network survey and analysis process.

Document analysis

Multiple drafts of the IA EAB Readiness plan directly pertaining to policies, programs, and quarantines surrounding EAB in Iowa were examined. This document addresses ash material movement into and around counties within Iowa and also dictates the nature of ash material movement amongst neighboring states such as Illinois, Wisconsin, and Minnesota where EAB has already been found in large numbers. These documents add to our understanding of invasive pest and pathogen policy genesis and evolution. Because of the ever-expanding nature of EAB, the readiness plan is a constantly updated document, with input from many sources including communities and university Extension officials. We examined two different plan drafts spanning nearly three years and assessed the plan for its ability to encourage co-management and collaboration amongst agencies and organizations in Iowa to work towards adaptive management of EAB. The documents were analyzed utilizing a qualitative analysis and "coding" process that aligned with the analysis of the interviews described below.

In-depth interviews and qualitative analysis

We conducted in depth, semi structured interviews with all 11 formal members of the Iowa EAB Executive council; we received the required approval to conduct participant research from Iowa State University's Institutional Review Board. The interviewees were chosen based on their membership in the council. Individuals represented diverse disciplines

and roles and included foresters, entomologists, and horticulturalists and occupied various positions of responsibility within and outside of the state of Iowa. Organizations represented included the Iowa State University Extension Service, the Iowa Department of Natural Resources, USDA Forest Service, USDA Plant Protection and Quarantine, and USDA Animal and Plant Health Inspection Services.

Interview contents

Interviewees were asked about their professional background, current role, and agency's or organization's role and responsibilities in the context of EAB. We then inquired about policies that interviewees contribute to that directly or indirectly relate to the pest, and how their role with respect to EAB has changed since its discovery. Also, we asked interviewees to estimate what their agencies role with respect to EAB would be in the future (for example, when EAB is more widespread in Iowa) in an effort to characterize the extent of their jurisdiction when it comes to EAB management. It was also important that we clarify the types of data respondents use in their agency to address EAB, and if there was any data that they do not have currently but would find useful should they receive it. Regarding resource availability and budgets, we asked where any EAB monies originate and how that money is specifically allocated towards response efforts.

During the interview process, interviewees were also asked to identify or nominate those with which they exchanged information or resources. The nature of this relationship with other inter- and intra-state agencies was also clarified using a table to delineate the frequency of the interaction, the type of resources exchanged, and whether or not they have coordinated work efforts at any time. Their frequency of interaction responses were used to

create a network diagram or "sociogram" of the EAB readiness team to aid in visual interpretation of the team's communications with one another. To ascertain the extent of future collaborations surrounding EAB in Iowa, we asked about their expected collaborations with other agencies, organizations, or groups.

Finally, we noted respondent perspectives Iowa's EAB readiness plan, and how it may or may not contribute to collaboration amongst various local and state-level stakeholders, as well as any ways the respondent saw to improve existing learning and collaboration surrounding EAB.

Our interviews were digitally recorded, with the permission of interviewees, and then transcribed by members of the research team. Data, including interview text and the electronic policy documents, were coded using an open coding process, which is a way to initially organize interview narratives by effectively identifying and categorizing key words or whole narratives (Hennink et al., 2011). The process of open coding has several steps, each which delve deeper into the data with further levels of analysis. During the coding process and subsequent code analysis, themes in the responses and sub-themes emerge (Strauss et al., 1990; Burnard, 1991). As per Saldana (2008), our nesting process continued until there were no more ways to describe the data and the data interpretation was effectively exhausted (Saldana, 2008).

An additional technique used for our assessment is called Social network analysis (SNA). A social network analysis was conducted on the IA EAB readiness team to ascertain the degree to which members worked together on EAB related issues. Examining stakeholder networks can help to illustrate the complex and broad nature of the relationships between

various entities (Bodin and Crona, 2009). SNA is a process conducted through the use of specially designed stakeholder surveys or interview techniques (Marsden, 1990) and analyzed with network analysis software (e.g., UCINET, Borgatti et al., 2002). This process provides the user with a diagrammatic representation (a sociogram) showing characterizations of relationships in the network as well as information flow, and can be used to distill a complex network into a simple visual aid (Scott, 2000). The raw network data can then be used to depict specific network measures such as centrality that get at descriptive measures of individual actors and their place in the network (Sozen and Sagsan, 2010). The metric of centrality measures how interconnected a node is in the network (Bodin et al., 2006), and allows us one measure to build upon qualitative knowledge gained through the interview process.

Results

We present information from our qualitative analysis of policy documents as well as in-depth interviews with state-level personnel involved with the EAB Readiness Team. The results are organized to reflect four key areas that emerged from the qualitative analysis: 1) adaptive elements of Iowa's readiness strategy, 2) information networks and co-management, 3) communication and resource sharing, and 4) future roles and learning.

Adaptive elements of Iowa's strategy to address EAB

We found that a policy document ("Iowa's readiness plan") and a formal team of stakeholders ("readiness team") serve as the foundation to Iowa's strategy to address EAB. Through the lens of adaptive co-management, we described and assessed aspects of the plan

and function of the team, and we highlight changes that were evident in the dynamic nature of the plan and associated function of the team.

Iowa's readiness plan

Iowa's readiness plan to address EAB is considered a dynamic document. Thus, drafts of the readiness plan were analyzed in an effort to identify changes in the state's strategy for EAB mitigation efforts and the key features of the current plan. We found that the Iowa EAB readiness' plan has evolved over the last three years, moving from an early focus on pre-emptive monitoring to an emphasis on active strategies for mitigating damage resulting from the presence of EAB. Overall, the plan currently outlines an approach to minimize risk of EAB infestation, and in the event of widespread infestation, the plan identifies the means to mitigate damages in the state by outlining prescribed approaches wherever possible. These goals are accomplished through the creation of a formal readiness coalition who then in turn manage the readiness plan and policy actions to be taken once EAB arrives. Further, the plan dictates educational and outreach programs as well as monitoring, regulation, and quarantine requirements pertaining to EAB detection and movement.

Organizations designated to create the plan and forming the Iowa EAB executive council are: Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa Department of Natural Resources – Forestry Bureau (IDNR), Iowa State University Extension (ISUEO), United States Department of Agriculture – Plant Protection and Quarantine (USDA-PPQ), and the USDA – Forest Service. In the sections that follow, we will describe the nature of the document and changes that have been made to it that

demonstrate Iowa's ability to adapt to new circumstances and information as it has become available. The plan outlines several areas of preparation: 1) General readiness (defined as reducing risk, minimizing impact, responding effectively to possible infestations by EAB, and partnering to achieve overall health and sustainability of forests, both urban and rural, throughout Iowa); 2) Reducing the risk of infestation; 3) Conducting a statewide monitoring program; 4) Identifying actions to take in the event of an infestation; and 5) Identifying appropriate actions if EAB cannot be contained.

In the general readiness section of the plan, two stakeholder groups are identified as serving distinct functions, including the Iowa EAB Executive Council, which is tasked with the response to an EAB infestation. A second group, the Communications Team adds other organizations and non-profits to enhance dissemination of information after an outbreak. Iowa State University Extension and Outreach is responsible to lead this team and oversee other organizations including the Iowa Arborist Association (IAA), the Iowa Nursery and Landscape Association (INLA), the Iowa Association of County Conservation Boards (IACCB), the Iowa Environmental Council (IEC), Trees Forever. The goal of the communications team is to spread information quickly and accurately and to offer support to the technical team in the event of an outbreak.

Part two of the readiness plan outlines educational and outreach programs focused on reducing the risk of EAB infestation in Iowa communities. Such programs are to include information on the risks associated with EAB and ash material transport, which is provided to private industries and Iowa citizens through communication channels to local governments, businesses, and residents. The primary goal education and outreach is to minimize movement of firewood, nursery stock, and related ash materials such as slash and

wood chips to control spread of EAB-infested materials. An additional goal identified in this

part of the plan is to recommend that communities conduct street tree inventories if they had

not already done so. Finally, this part of the plan recommended that any remaining ash tree

nursery stock be quickly removed. A variety of planting selections are being promoted by

educating nursery owners and municipalities about factors that contribute to maintaining a

'diverse and sustainable' urban forest. One respondent told of this effort:

> And we're also going to have to work with shifting into
>
> convincing these small communities… homeowners… that
>
> they shouldn't just plant maples, that they shouldn't just plant
>
> hickories or something like that, or oaks…we have to learn
>
> from our past and now preach more of a diverse planting.

Iowa's readiness team

The Iowa EAB executive council consists of members from local government, and

state and federal agencies and is identified within the readiness plan as the group responsible

for design and implementation of EAB policy. The main objective of this group as outlined

in the plan is to reduce risk, minimize impact, and respond effectively to a possible

infestation of EAB. Further, this group is charged with collaborating to support overall

health and sustainability of forests, both urban and rural, throughout Iowa. Within the team,

organizations are identified as holding specific roles in decision making and different levels

of communication influence. Through our qualitative assessment of various roles and levels

of communication as described in the plan we identified three categories [spheres/areas] of

influence; regulatory and enforcement, technical assistance and data gathering, and communications and data gathering.

The first category of influence includes members from various organizations responsible for regulatory and enforcement and these members appeared to be given most responsibility and these members are expected to meet regularly. The first level we identified largely involves the communications team which is made up of entomology, forestry, and horticulture specialists with cooperative Extension and the Iowa Department of Natural Resources who are tasked with collecting and analyzing incoming data with regard to pest identification, detection and spread and then communicating it with the technical team (level 2). From there, the information is shared with other Iowa Inter-state agencies within the EAB council (the technical team) to help inform the design of regulations and setting of quarantines that can dictate movement of sensitive materials into and around the state. At the state and federal level (level 3, the top-most level), funds are allocated to various groups and policy is finally set by the regulatory agencies including IDALS, the Iowa DNR, and ultimately the US Forest Service.

Adaptive elements

Through our qualitative analysis of the interviews with EAB readiness team members we identified. We sought to determine the degree to which the readiness plan encouraged or discouraged collaboration among the agencies involved. The plan provided some initial insight into the nature of relationships between agencies, we use additional data from in-depth interviews and document analysis to further examine this aspect.

Overall, team members understood that one purpose of the readiness plan was to encourage collaboration, with some caveats. The plan was described as "workable" by one

respondent, who stated that Iowa was in a good position relative to other states since it could develop both proactive and reactive plans, as opposed to being forced into a reactive mode , as happened in other states (such as Michigan, which one respondent noted "got caught [off guard]". Iowa's plan was also described as "seasoned" in that it reflected learning from other states including both Michigan and Illinois. However, it was also noted repeatedly by team members from several agencies that they had "no idea if (the plan) is going to work", and team members were effectively in a "wait and see" mode.

The plan did exhibit many themes of adaptive management. The plan mandates co-management in that agencies are to support one another in their roles, including pest management, information sharing, and resource allocation. Team members were advised to "foster cooperation" for implementation of readiness plan actions. Team member roles were also clearly delineated, with lead members nominated in each level of management (IDALS and IDNR in the technical team, Extension in the communications team) to facilitate communication at each level of decision-making. Additionally, the plan encouraged learning through regular meetings and the "dynamic" nature of the readiness plan document itself. Elements of adaptive governance as identified through our analysis included co-management, communication delineation, collaboration, resource sharing, learning, and ultimately adaptation (Table 1).

The elements of co-management, collaboration, learning, and adaptation appeared to guide the EAB team and facilitate collaboration by helping team members perform their duties in an effective and informed manner. Many if not all of these elements may need to be in place for adaptive governance on the issue of pest management to proceed effectively. Our identification of the team's use of these adaptive governance elements, including successes

and constraints, offer further insights on how the team is approaching management issues since its genesis in early 2010. These adaptive elements will be discussed in the sections below.

Information networks and co-management

Interviewees were also asked to describe their roles related EAB and pest management. The majority of EAB team members, led largely by university Extension and DNR employees are involved in activities and actions which involve technical assistance and data gathering. One university Extension member's primary role was described as offering support to the regulatory team and this was accomplished by providing on-the-ground, local-level information received in the course of their duties as well as responding to citizen questions regarding EAB. Cross-scale interactions were evident – for example, across institutional scales as Extension connected knowledge gained through local or regional actors (sawmills, individual landowners etc.) to others on the EAB team. One respondent had this to say about their role within Extension:

> What we do then is we also sit on the EAB committee where we get the most up to date information where we also share with them our concerns for regulations, when policy is being set….We bring them the public's perception.…We sit at the table with all of those folks. Now we don't have the final say, but our voice is heard and it really is, in terms of some of the decisions, it really is a group decision that we are involved with EAB.

This perspective represents the shared decision-making process despite the specific roles mandated in the EAB readiness plan. Another respondent offered a broader perspective of all agencies and entities involved on the EAB team:

> I see Extension as the outreach arm, and then you've got Iowa State University that's, you know, outreach/research. We've got DNR and then they have their roles as defined by the legislature and the protection of forest lands in the state of Iowa. You've got USDA that is also a regulatory agency but they are inter-state in nature, where the Iowa Department of Agriculture is intra-state in nature. And then you've got the Forest Service and how they play into it and then recently with the advent of private entities… quasi-public/private entities, they would like to be highly involved also.

These levels determined the flow of information within the team and the nature of communication between team members and agencies. We used data from interviewees to construct a network diagram, which provides a visual representation of the relationships among team members in this study (Fig. 2). During interviews, team members were asked to identify others within the team whom they communicated with to share information or resources. Network "nodes" (representative of individuals or "actors") were sized by degree centrality (an actor's relative measure of prominence in the network). Incoming ties (an indicator of how often a particular actor was nominated as a collaborator) are also represented visually in the diagrams by the connections between nodes or "links". These nodes are color coded to by different actor groups (red is data gathering, blue is policy

setting). Resulting ties between actors were symmetrized (member nominations in either direction were included).

Team members preferentially communicated with specific individuals and agencies. The more peripheral Extension agencies are interacting with fewer agencies on the team than the regulatory and enforcement agencies, who are relatively more central. We surmise that regulatory and enforcement agencies (blue) must communicate with a larger number of entities to properly inform their policy decisions and effectively co-manage on issues of pest management concern. Given the role that Extension staff fills in communicating with other external stakeholder groups, these seemingly peripheral network members may serve as bridging organizations that encourage the flow of information to and from the central groups who would otherwise be disconnected from on the ground information sources (Berkes 2009). Therefore, with our network diagram being bounded to only EAB team members, further research may be needed to fully understand the networking role that those staff in Extension may provide outside of this group.

Constraints to adaptive management and creative solutions

Budget constraints were consistently identified by team members as a challenge in management for EAB. In the case of state agencies (e.g., IDNR and IDALS), competition for funding from the same state legislature caused tension between agencies. One respondent characterized it this way:

> Again, we're once-removed from playground politics. You
> know, if somebody's getting money and somebody isn't, or if
> the work is being done by someone they don't agree with how

it's being done…Or if somebody runs the numbers and [funding received] doesn't cover the costs, they're not going to do it, which puts hardship on somebody else [within the team] because then they have to pick up the slack…So a lot of it comes down to budgets, we're all tight.

During our study when EAB was identified in…in anticipation of the arrival of an invasive pest, members from the readiness team described the various tasks to be completed that carry direct costs: setting tracking traps and monitoring sentinel trees to detect/track EAB movement, policing movement of ash materials, and enforcing quarantines. We found through the interviews with team members that given the growing number of responsibilities related to their EAB strategy, members often hold multiple roles, while still retaining their current formal job responsibilities that may or may not directly relate to the spread of EAB. As a result, some individuals felt that they aren't necessarily strategically poised to take on new issues immediately as they arise. In the context of technical assistance and data gathering, the agencies involved often will have to tie in new funds for EAB management to existing programs (such as tree workshops or existing monitoring efforts), as seen in this perspective by a respondent:

When you think about all of Extension responding to Emerald Ash Borer, we're going to use bits and pieces from all [available] pots of money. It's never enough [to begin with], then it's decreasing ...[we've become] very creative in trying to piggy-back Emerald Ash Borer into existing programs, which is why it shows up in Master Gardener and pesticide applicator

training because those are already going on and paid for…we

don't have to have the money to start up something special.

We also found that EAB readiness Team efforts are focused on specific pest

management activities are also constrained by this aspect of funding allocation: the Iowa

DNR receives the vast majority of its funding from federal dollars. One respondent summed

it up this way:

Their entire program on forest health is pretty much run by

federal dollars, by federal pass-through and grant dollars that

[the Iowa DNR] get from the Forest Service. Very little comes

from the general operating fund here at the DNR now…you

know they're living at the mercy of the Forest Service.

In this instance, the DNR can only proceed with management decisions that they have

the funds for, and at least one staff member noted that budgetary constraints have distinctly

challenged their EAB tracking efforts; an issue of increasing concern as EAB continues to

spread throughout Iowa.

Another constraint that emerged from was related to the importance of

communication among members, and challenge related to inconsistent communication. For

example, we found that the communication of information and sharing of EAB updates was

often complicated by the structure of the network, issues related to the spread and detection

of EAB, including the size and diversity of the network, the spatial and temporal dynamics of

EAB movement, the difficulties related to confirming EAB infestation/emergence, and the

protocols for controlling the movement of information. Of note, several interviewees have

found that the flow of information between team members was not always timely, causing delays in action and leading to internal team conflict for individuals with "action"-related responsibilities. Because of role overlap there were times when communication stalled due to "crossed-assumptions" of an action effectively being the job of a different agency, thus leading to a delay in the performance of a necessary task. There was also a "hierarchy" effect particularly for early communication, which was often unidirectional or isolated among a "core" group that formed within the team framework. The issue of legality also hampered communication. Chain-of-command regarding information release was not explicitly identified in the Readiness Plan, which occasionally caused further conflict.

Perspectives on the issue of internal communication ranged widely among participants. Overall, several interviewees noted that communication has improved over time, showing learning and adaptation by team members. The relationships among agencies appears to have also improved as the readiness team tackled new issues with enhanced collaborative approaches, mentioned by multiple interviewees. Of note, sometimes complex communication dilemmas were been found by members to have relatively simple solutions. One respondent had this to say about the nature of communication within the team:

> We now have learned it's "reply to all" so everybody gets everybody's message from that core team. Sometimes...[an individual] didn't know legally if they could give out information, you know. When first things come down through, because there is a [legal] hierarchy of who can release information....

Future roles and learning

Interviewees were also asked what they anticipated their future collaborations within the EAB team would be, and what could be done to improve the effectiveness of future collaboration. One team member described how the team's collaborative efforts could be more focused:

> I would really like to see an Emerald Ash Borer coordinator. Someone that can be dedicated…A lot of other states have managed to put a coordinator in place, and I think if we had someone who could dedicate themselves to it full time then there wouldn't be all these loose ends and instead of, you know, looking to Extension to write a new outreach piece, we have a coordinator that can write it and then everyone else can vet it, it doesn't take as much of their time.

In essence, the respondent notes that if more state-level funds were allocated to EAB management through the form of a coordinator, it may allow for more focused collaborative efforts and more effective implementation of readiness plan objectives.

Importantly, we wanted to assess how team member roles had changed over time (since EAB was found in the state in early 2010), and how responsibilities were likely to continue to evolve in an effort to determine how management strategies may change. Respondents alluded to changes in their roles and responsibilities, with the likelihood of expanded roles engaging with citizens and community leaders, both through direct communication and via various types of publications (e.g., extension/outreach oriented

materials for the general public as well as more technical materials for the scientific community as well as district and urban foresters, professional arborists and tree service technicians, nursery managers) As described by a number of respondents, the immediate nature of the EAB threat has resulted in increasing concern (on the part of citizens as well as those organizations and businesses mentioned above) and greater numbers of contacts to the team to determine the proper courses of action for specific EAB and tree management problems. A respondent told of their experiences and how their responsibilities have evolved from providing broad public education to more focused guidance in directly managing future hazard trees and the handling of infested wood material as EAB moves into the state:

> [The way we do things] is going to change ... when [EAB] really gets here. Right now…there's no money...towards mitigating damages… [S]o, all we're doing right now is educating [the public] on the biology of the insect, what to look for, who to contact [in their area], talking about the quarantines. And then we're going to have to shift, and it'll pretty much fall to us once it gets here. …we're going to have to work with the DNR, their district foresters. We're going to have to work with landowners.

Many team members echoed this sentiment, and all respondents noted that their roles within their organizations and agencies have changed.

Discussion

In order to adequately combat the threat of invasive species and other natural resource issues, a network of natural resource specialists from many different disciplines and who hold various levels of responsibility (i.e., areas of expertise, power) across a region, can be mobilized to assess and learn from the current situation; design, facilitate, and adapt the application of natural resource policy; and negotiate and facilitate future management *(*Schultz et al., 2011*).* Importantly, these governing bodies are necessary to co-manage across different spatial areas and scales in a process that builds a collective understanding (Borrini, 2004).

Iowa's current strategy involves the clear articulation of EAB mitigating efforts through a formally designed EAB Readiness Plan and a well delineated EAB readiness team that draws on information and expertise from a wide variety of disciplines, both technical and regulatory. Through a combined qualitative and quantitative approach (informal interview questions and a formal network analysis), we are able to build upon our understanding of adaptive management surrounding issues of natural resource concern. Using this case-study approach, we are able to reveal some new insights and conclusions regarding co-management surrounding the ever-important issue of invasive pests so that other states, communities, and natural resource managers may learn from Iowa's approach.

Although the state of Iowa has a defined approach to adaptive management at the broad level, as with other states that had some time to prepare as EAB moved out from Michigan (e.g., Illinois, Ohio), the sheer scale of EAB will certainly challenge any planning that has been done (e.g., Sydnor, 2007; IL Dept. of Ag., 2012). Over the course of our

interviews and document analysis, we learned the degree and nature of collaboration on EAB related issues, and nuances in the relationships of those in a leadership position on pest management issues. Relationship building among representative individuals from the various state and federal agencies has often been hampered by communication within the team, occasionally going so far as to impede progressive cross-agency collaboration between team members. Adding to this, budgetary constraints and limited time due to understaffed departments has threatened to impede plan implementation and EAB monitoring efforts. If future EAB management in Iowa is to proceed efficiently and effectively, efforts should be taken to mitigate or remove current constraints to facilitate overall collaborative efforts and promote adequate management.

Cohesive network

Our analysis of the formal Iowa EAB readiness team indicates a fairly cohesive network, which is an element of adaptive co-management widely seen as necessary for promoting satisfactory natural resource management (Folke et al., 2005). The sociogram of team members shows us that not only are all team members interconnected; regulatory agencies represented were found to be the most central (see figure 2). A clear ring of more peripheral Extension and DNR stakeholders feeds these more central regulatory actors with a steady stream of new information to adequately inform high level management decisions made with regard to EAB. Through the qualitative analysis of the Readiness Plan and team member interviews, it is seen that data gathering agencies inform regulatory decisions such as the setting of quarantines, and the nature of monitoring and information sharing efforts throughout the state. Additionally, we discovered a more informal network of stakeholders

(including arborists, local government, and NGO's) that inform the outer ring of Extension and DNR agencies on local issues happening within their respective jurisdictions.

These cross-scale networks greatly influence management decisions, despite information travelling through more peripheral entities, these individuals have an on-the-ground perspective that higher-level regulatory managers are not exposed to but that are critical to consider when making locally-informed management decisions. Maintaining connections with these more informal information networks will likely prove paramount in determining the way EAB is managed in the state. Theoretically, adaptive co-management and governance include these local-level actors and individuals as well across a variety of networks; multi-scale networks function to build upon these efforts. The network we are assessing is in essence the top-level professionals who help design and set policy; however, we have not fully assessed the degree to which these networks incorporate local-scale individuals. We do know that Extension professionals can serve as bridges of information in the system, given their responsibilities in working with landowners and communities. As one Extension agent noted, they often bring the regulatory officials "back to reality" on the specific issue of quarantines given that team members may have unique experience with business owners in the timber industry.

Our qualitative approach also gave us insights into the nature of team member interaction, and both positive and negative aspects were noted. The risk of conflict is inherent in the system of co-management (see Brody, 2003) and although the team has built upon their initial collaborative framework, improving in many ways, impediments to management are still apparent.

Communication: Information flow between team members was not always seen to be timely, causing action to be delayed and resulting in an undesired level of agency conflict that was noted by many respondents. Partially caused by unforeseen role overlap, these instances served to confound some team members as tasks appeared to be poorly delineated. A power differential was also in effect; a core group of individuals met more frequently and sometimes individuals or agencies were bypassed when it came to the issue of information sharing. In addition, the Readiness Plan doesn't clearly define who can share what types of information and when. Despite their being a readily apparent hierarchy of command, the dissemination of information continues to be an issue of concern amongst some team members.

Trust: Largely due to communication challenges, trust was an oft-discussed issue of concern within the team dynamic. Individual agencies were accused of claiming an accomplishment as their own, neglecting to mention their collaborative partners (some of whom are also in the readiness team). This is leading to an environment where collaboration between certain agencies is becoming increasingly difficult, as some individuals are preferentially choosing to not participate with one another. This has the potential to be devastating in a co-management situation; team members were chosen so they represented a variety of fields of expertise and mistrust may lead to a hampering of the team's ability to include all perspectives on pest management issues.

Role Evolution: Given the nature in which EAB affects ash trees (the pest reproduces for a number of years, then attacks and kills a host tree in a relatively short time frame) and the unpredictable movement pattern of EAB (including the fact that it is a recent pest to Iowa), time spent managing EAB will only increase. In the pre-EAB landscape, natural

resource managers were already overwhelmed with their day-to-day tasks; this pest is simply one more item on their laundry list of issues to address. In addition to the call for additional EAB monies (echoed by all respondents), at least one team member called for a new position to be created that deals solely with EAB related management efforts including monitoring, quarantines, and plan updates. Having a single individual focused on the general management for EAB could partially free up existing team members from this duty and may create an opportunity for more effective damage mitigation in the long run. This is especially relevant as more invasive pests and diseases will threaten the Iowa landscape over time.

Conclusion

The issues of note concerning the EAB team's ability to adaptively co-manage at the state level can be distilled into some general recommendations for future collaboration and management to combat invasive pest spread and mitigate damages as infestation occurs. This is especially prudent given the number of potentially damaging invasive pests on the horizon, a number that is steadily increasing.

Given the prominence of the Iowa EAB team in mitigating pest damage at the state level, importance should be placed on making sure that the team performs to the best of its ability. Trust is widely seen as important in effective collaboration (Adler et al., 2011). In order to be most effective, the team members must maintain a high level of trust in the agencies they collaborate with and the personnel that staff them. Also, due to the evolving nature of many employee and agency roles, it is imperative that team members stay up-to-speed about the nature of each agency's work to avoid unnecessary inefficiencies from role

overlap given limited budgets in addition to time constraints. Building trust will also help to future proof agency credibility amongst team members and other personnel by maintaining trustworthiness to deal with future pest issues as they become more prominent (Asian Longhorn Beetle, Gypsy Moth, Thousand Cankers, etc.).

Although roles are delineated within the readiness plan, the degree to which specific task responsibility is defined is somewhat more limited. This can be made especially confusing given some slight role overlap. Effort could be made to more clearly spell out agency duties to maintain an efficient pest management environment. For example, as new management tasks are added to the team's strategy, these could be partitioned up immediately amongst agencies so members are clear about who is doing what. An added benefit of this is that it will likely reduce the instances of mistrust that stem from concerns with communication; clear role delineation allows team members to more effectively disseminate information amongst the team and beyond to communities and local government officials.

As efforts are made to continually improve upon the collaborative framework on which effective pest management rests, we recommend that managers are continually on the lookout for novel ways to enhance the cooperative environment. Using relatively recent techniques such as Social Network Analysis along with the more classic approach of qualitative interview analysis, we were able to ascertain a broader picture of state level collaborative management on an important issue of natural resource concern. This information could help to inform future management decisions as invasive pests and diseases enter into the local jurisdiction of management groups; collaboratively co-managing to maintain satisfied stakeholders is an approach that is has been widely seen to be successful.

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Figures

Regulatory and Enforcement[1]

Iowa Dept. of Ag. And Land Stewardship (IDALS)

Iowa Dept. of Natural Resources – Forestry Bureau

USDA Animal and Plant Health Inspection Service (APHIS)

USDA Plant Protection and Quarantine (PPQ)

Affected local government(s) at site(s) of infestation

Technical assistance and data gathering

*IDALS – State Entomology Office

*IDNR Forestry Bureau

Cooperative Extension Services (Forestry, Entomology, Horticulture)

USDA APHIS PPQ

USDA Forest Service

Iowa Emergency Management Division

Communications and data gathering team (NGO's and local government)

*Cooperative Extension Services (Forestry, Entomology, Horticulture)

IDALS – State Entomologist's Office and IDALS Communication Officer

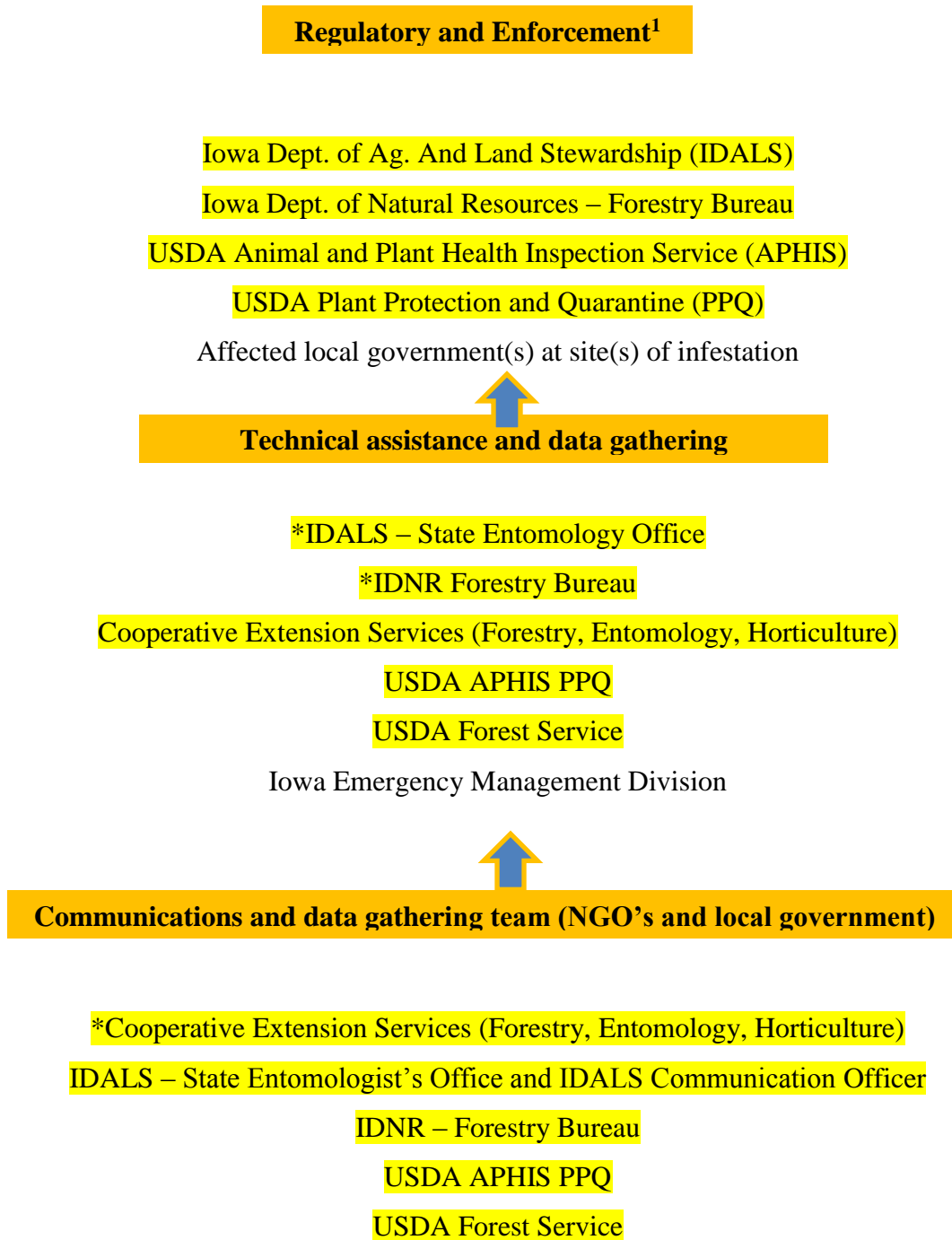IDNR – Forestry Bureau

USDA APHIS PPQ

USDA Forest Service

Figure 1: A hierarchical approach to readiness. Highlighted entities form the 'EAB Readiness team.' ***Denotes lead agency. [1]These agencies have by law "been assigned the responsibility of managing an exotic pest infestation and have been granted the legal authority to act by the federal, state, or local government."

Iowa State University
Iowa Arborists Association (IAA)
Iowa Nurseryman and Landscape Association (INLA)
Iowa Association of County Conservation Boards (IACCB)
Iowa League of Cities (ILC)
Governor's Representative, State of Iowa
Iowa State Association of Counties (ISAC)
Iowa Society of American Foresters (SAF)
Iowa Environmental Council (IEC)
Meskwaki Natural Resources
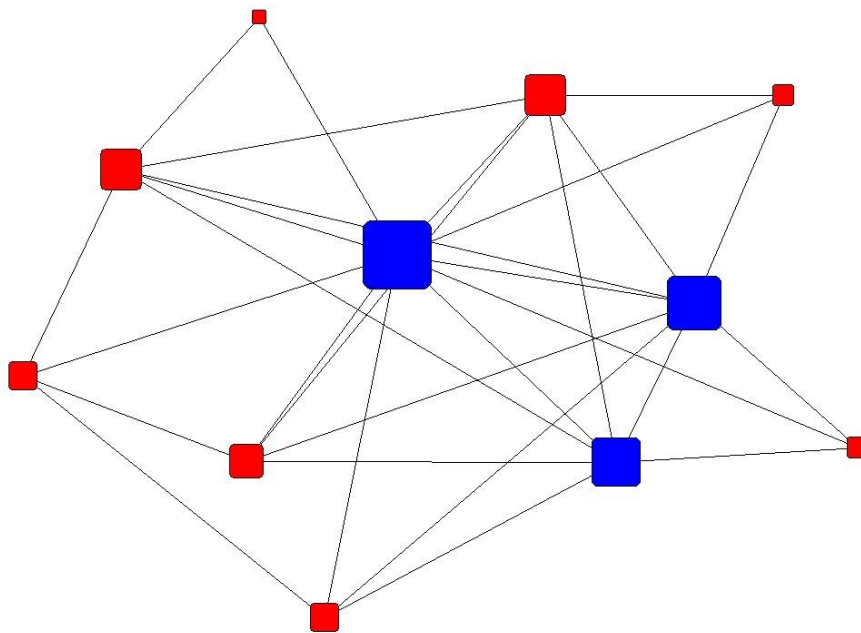Trees Forever

Figure 1 continued

Figure 2. Visualization of the informal EAB team network (sociogram). The red represents the technical assistance and data gathering agencies, blue represents state and federal regulatory agencies.

Tables

Table 1: Adaptive governance elements of the IA EAB readiness plan implemented by way of the IA EAB readiness team.

Element	Element of Readiness Plan and EAB team
Co-management	Diverse composition: DNR, Extension (horticulture, forestry, entomology), Regulatory, and enforcement agencies formally represented.
Power Hierarchy	Clear Responsibilities: The team has well delineated roles to help prevent role overlap.
Collaboration	Multi-level organization: Regulatory and technical teams communicate with local officials to gather data and spread information.
Resource and Information sharing	Transparency: The EAB team disseminates available EAB funding and information through formal channels.
Learning	Regular meetings: The team regularly gathers to set policy (quarantines, compliance), based on information gathered from all sources represented.
Adaptation	Evolution: The plan undergoes revision upon novel information.

CHAPTER IV: GENERAL SUMMARY

Iowa is facing challenges from a new invasive pest, the Emerald Ash Borer. As this pest moves further into the state, managers at the state and local level will be focusing on planning and damage mitigation strategies that produce favorable outcomes for all stakeholders involved. In order to provide for best management, the interactions of the state level EAB readiness team were analyzed to determine the effectiveness of their strategies; what is working well and what areas need improvement. The understanding of the team's dynamics and power structures, as well as their interactions with local level stakeholders, will help to provide for a favorable result in the management of not just EAB, but future pests that widely impact the state (Folke et al., 2005). Although readiness team members cooperate well with one another to a large degree, issues involving mistrust and communication, as well as varying degrees of role overlap were seen as concerning.

Adding to this, local level stakeholder interactions and adaptations surrounding EAB were documented to better understand the way local communities will handle a full-fledged pest invasion. The way that these tree management and end-use entities communicate and collaborate will largely determine pest management outcomes at the local level (Pretty, 2003). The knowledge of these formal and informal networks will aide in management at this scale, as city officials and natural resource managers can use this information to better allocate funding, workload, and resources for maximum damage mitigation and recovery.

We created a new metric for measuring overall stakeholder preparedness for EAB (new business adaptations), and found that public sector entities in these communities are generally preparing for EAB; the private sector is preparing as well but to a lesser degree

(roughly half as much). Additionally, we determined that public sector stakeholders will likely not be able to handle the rising workloads as EAB becomes fully established in a community, and they will likely rely on contracts with the private sector to adequately mitigate damages. Through our social network analysis, we discovered that some businesses in the private sector are only tied into community stakeholder networks via one other stakeholder or 'actor'. These businesses may prove crucial in a post-EAB situation (assisting with cleanup and replanting), but may find it difficult to secure contracts or otherwise capitalize on the influx of woody material if they aren't well collaborated.

Our results at both the state and local level support the existing literature in the area of collaboration; stakeholder collaboration across a variety of disciplines and areas of expertise is integral in sound natural resource management (Flint and Luloff, 2007; Bodin and Crona, 2009). Our recommendation is to use the information garnered in this study to plan for pest impact at both the state and local level and to produce policy that encourages stakeholder engagement and collaboration. Additionally, we suggest that future research be conducted on the after-effects of pest infestation given existing stakeholder networks; how effectively were damages mitigated?

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APPENDIX A: STRUCTURED INTERVIEW GUIDE FOR EAB TEAM MEMBERS

Would it be alright if I record this interview? It will help me to capture your words most accurately. *[Remember to have them clarify anything that is uncertain.]*

Yes / No *[If they agree, then turn on the recorder, otherwise continue to take written notes only.]*

So you are currently the Iowa Urban Forestry Coordinator:

1. Have you held any other positions in the past?

2. What is your department's role with respect to tree pests and pathogens in general?

3. What is your department's role <u>specifically</u> with respect to EAB?

    a. What state or federal policies or programs do you design or carry out that relate to EAB?

    b. In what way has your department's role changed over time with respect to EAB? *[Probe: What time period?]*

    c. What do you expect will be your department's role in the future with respect to EAB?

    d. What kinds of data do you [or your agency] use to address EAB? *[Probe: Where does this data come from?]*

        i. What kinds of data would help you in your role addressing EAB that you currently don't have?

    e. With respect to EAB, where does your agency's budget come from? *[Probe: How is this budget allocated towards addressing EAB in Iowa?]*

    f. Overall, what are the main impacts that you see your department has on the spread of EAB?

g. What are the main impacts that your department will have in the future on management of EAB infestations?

[After g hand them the table with their network connections on it and ask if there are any more.]

h. Are there any ways in which you have found Iowa's EAB readiness plan to encourage collaboration?

i. How has collaboration and learning among agencies, organizations or groups been constrained in the past?

j. In what ways could collaboration and learning be improved among agencies, organizations, or groups to address EAB?

APPENDIX B: FIRST MAILING COVER LETTER FOR SURVEY

3/5/2012

Address

Dear Stakeholder,

As researchers at Iowa State University's Natural Resource Ecology and Management Department, we are conducting a Leopold Center funded research project dealing with an invasive insect pest that is currently of concern to Iowans: the Emerald Ash Borer (EAB). Part of this research includes a brief survey of local businesses and organizations, which we have included in this mailing. Through this survey, we hope to learn about the different perspectives of local business owners and those who work with municipalities with regard to EAB, which will help us better design information and assistance to stakeholders in a way that captures wood use opportunities while minimizing costs related to tree removals.

As a business owner, manager, or city manager or staff, you have been selected to help represent the perspectives of local stakeholders in [your city]. This spring, you will also receive an invitation to an EAB workshop, to take place in [your city] in April, where we will share our findings and bring together professionals to discuss urban wood use and tree planting in the wake of invasive pests and pathogens. Participation is this survey is voluntary, and you may opt out of any questions that you do not wish to answer. It is very important that your opinions and experiences are included, and any information that you do provide will be kept confidential. Your answers will be combined with those of others who respond and will be reported in summary form only. Please take a few minutes to complete the attached survey and return it as soon as possible in the provided pre-stamped envelope. If you have any questions regarding the survey, please contact us at any time. Thanks for your help and we hope to see you at the workshops in April!

Sincerely,

Justin Landhuis   Tricia Knoot
Graduate Assistant   Research Associate
Iowa State University   Iowa State University
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APPENDIX C: REMINDER POSTCARD FOR SURVEY

Iowa State University

IOWA STATE UNIVERSITY

DEPARTMENT OF NATURAL RESOURCE ECOLOGY AND MGMT

We recently sent a survey regarding our research with an invasive insect pest: the Emerald Ash Borer as it relates to your business. We value your perspective and hope that you can take the time to complete our survey. Feel free to contact us with any questions.

If you have already completed our survey, thank you and please disregard this reminder.

Thank you,

Justin Landhuis

Justin Landhuis
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APPENDIX D: SURVEY TOOL

IOWA STATE UNIVERSITY STAKEHOLDER SURVEY
Emerald Ash Borer: Mitigating Costs & Capturing Opportunity

Thank you very much for participating in this important survey! The Emerald Ash Borer, a non-native insect tree pest, is currently of concern to Iowans given the prevalence of Ash trees in the state. You have been contacted as part of a broad and diverse group of stakeholders, including city officials, tree services, sawmills, tree nurseries, and volunteer organizations in and around [Their city]. Your completed answers to this survey will help us better understand the perceived impact of EAB in your community and how businesses may work together in the future towards innovative wood utilization strategies in the face of EAB and other tree pests and diseases. This information will be kept strictly confidential and all information will be used in summary form only.

Section 1: Background information

1)   Please choose the category below that best describes your business or organization:
   (*Please check only one box*)

   ☐ A.   Tree Service / Arborist

   ☐ B.   Tree Nursery / Landscaping / Tree Farm

   ☐ C.   Sawmill / Lumber Company

   ☐ D.   Professional Forester

   ☐ E.   Firewood Dealer

   ☐ F.   Primary Wood Byproducts (animal bedding, mulch, etc.)

   ☐ G.   Secondary Wood Products (doors, windows, cabinets, etc.)

   ☐ H.   Volunteer Organization / Non-profit Organization

   ☐ I.   Power / Energy Sector

   ☐ J.   City Government (Tree Board, Parks and Rec., Waste Facility, City Manager)

   ☐ K.   Other: _____

2)   How long has your business or organization been operating?
   (*If you are referring to a city government, you may answer N/A—not applicable*)
   _____# years in operation

3)   Please describe your primary role or position within this business or organization?
   _____

4)   How long have you been with this business or organization?
   _____# years

5) **What is the size of your business, organization, or division?**
        A._____# permanent, full-time, employees
        B._____# permanent, part-time, employees
        C._____# seasonal employees
        D._____# volunteers

Section 2. Your perspectives on EAB in your community and the ways in which it may impact your business or organization.

6) **Please indicate your perspective on the spread of Emerald Ash Borer (EAB) to your community:**

☐ A.   EAB is likely already here

☐ B.   Will be identified in the next 1-5 years

☐ C.   Will be identified in the next 5-10 years

☐ D.   Will be identified in more than 10 years

☐ E.   Unsure

7) **In what ways do you see or have you seen EAB impacting the work of your business or organization?**

8) **In what ways (positive or negative) do you see EAB impacting your business or organization in the future?** (*Please check all that apply*)

☐ A.   Very positive

☐ B.   Somewhat positive

☐ C.   No impact

☐ D.   Somewhat negative

☐ E.   Very negative

☐ F.   Unsure

9) **Please describe in more detail the ways in which you feel EAB will impact your work:**

	Have done	Expect to do	Won't Do
A. Change standards and rules within our business	☐ ☐	☐ ☐	☐ ☐
B. Capital investment: e.g., will buy new equipment	☐ ☐	☐ ☐	☐ ☐
C. Hire new permanent (year-round) employees	☐ ☐	☐ ☐	☐ ☐
D. Hire new seasonal employees	☐ ☐	☐ ☐	☐ ☐
E. Provide additional training to employees	☐ ☐	☐ ☐	☐ ☐

F.	Change employee roles or duties	☐	☐	☐ ☐	☐ ☐	
G.	Create new collaborations within Dubuque	☐	☐	☐ ☐	☐ ☐	
H.	Create new collaborations outside of Dubuque	☐	☐	☐ ☐	☐ ☐	
I.	Develop new marketing or communication strategies	☐	☐	☐ ☐	☐ ☐	
J.	Seek grants or business loans	☐	☐	☐ ☐	☐ ☐	
K.	Expand into a secondary market (Firewood etc.)	☐	☐	☐ ☐	☐ ☐	
L.	Other: _____	☐	☐	☐ ☐	☐ ☐	

11) In what format do you prefer to receive information about tree pests and pathogens?
(Please select one)

☐ A. Newspaper

☐ B. Television

☐ C. Radio

☐ D. Internet

☐ E. In-person workshops or information sessions

☐ F. Newsletters

☐ G. Other: _____

12) What workshops have you already attended in relation to tree health or tree pests?
(Please check all that apply)

☐ A. Iowa State University Extension Shade Tree Short Course

☐ B. Iowa State University Extension Bark Peeling Workshop

☐ C. Other:_____

☐ D. Other:_____

13) **What groups do you receive information from about tree pests and pathogens?**
(*Please check all that apply*)

☐ A.   Neighbors, friends, or family

☐ B.   University extension specialist

☐ C.   Forester or resource specialist from the Department of Natural Resources (DNR)

☐ D.   Private tree service staff or professional arborist

☐ E.   Company representative that develops or sells tree insecticides and fungicides

☐ F.   DNR newsletters or website

☐ G.   Informational materials from organizations in which you are a member

☐ H.   I don't receive tree pest and pathogen information

☐ I.   Other: _____

☐ J.   Other: _____

Section 3: We are trying to understand the arrangement of current business connections, which will help us identify ways to increase opportunities for innovation to address the spread of EAB.

14)   **For those businesses, organizations, or groups listed below (and on the following pages), please indicate how often you interact with them and if the different resources are shared.**

Business / Organization / Group	Interaction Frequency: *1=Rarely (1-2 times a year)* *2=Occasionally* *3=Often (once a month or more)*			Exchange of Resources: *Yes / No*		
				Information or Expertise	**Labor or Equipment**	**Finances**
Tree Services:	Rarely…………………………….Often					
Example: Bob's Tree Trimming	1	2	3	Yes No	Yes No	Yes No
1.	1	2	3	Yes No	Yes No	Yes No

2.	1	2	3	Yes	No	Yes	No	Yes	No
3.	1	2	3	Yes	No	Yes	No	Yes	No
4.	1	2	3	Yes	No	Yes	No	Yes	No
5.	1	2	3	Yes	No	Yes	No	Yes	No
6.	1	2	3	Yes	No	Yes	No	Yes	No
7.	1	2	3	Yes	No	Yes	No	Yes	No
8.	1	2	3	Yes	No	Yes	No	Yes	No
9.	1	2	3	Yes	No	Yes	No	Yes	No
10.	1	2	3	Yes	No	Yes	No	Yes	No
11.	1	2	3	Yes	No	Yes	No	Yes	No
12.	1	2	3	Yes	No	Yes	No	Yes	No

Business / Organization / Group	How often do you interact? *1=Rarely (1-2 times a year)* *2=Occasionally* *3=Often (once a month or more)*			Do you exchange resources?					
				Information or Expertise		**Labor or Equipment**		**Finances**	
Nurseries / Garden Centers :	**Rarely…………………….Often**								
13.	1	2	3	Yes	No	Yes	No	Yes	No
14.	1	2	3	Yes	No	Yes	No	Yes	No
15.	1	2	3	Yes	No	Yes	No	Yes	No
16.	1	2	3	Yes	No	Yes	No	Yes	No
17.	1	2	3	Yes	No	Yes	No	Yes	No
18.	1	2	3	Yes	No	Yes	No	Yes	No
19.	1	2	3	Yes	No	Yes	No	Yes	No
20.	1	2	3	Yes	No	Yes	No	Yes	No
21.	1	2	3	Yes	No	Yes	No	Yes	No
22.	1	2	3	Yes	No	Yes	No	Yes	No
Landscape Contractors:	**Rarely……………………Often**			**Information or Expertise**		**Labor or Equipment**		**Finances**	
23.	1	2	3	Yes	No	Yes	No	Yes	No
24.	1	2	3	Yes	No	Yes	No	Yes	No
25.	1	2	3	Yes	No	Yes	No	Yes	No
26.	1	2	3	Yes	No	Yes	No	Yes	No
Sawmill/Lumber:	**Rarely……………………Often**			**Information or Expertise**		**Labor or Equipment**		**Finances**	
27.	1	2	3	Yes	No	Yes	No	Yes	No
Primary Wood Byproducts:	**Rarely……………………Often**			**Information or Expertise**		**Labor or Equipment**		**Finances**	
28.	1	2	3	Yes	No	Yes	No	Yes	No
29.	1	2	3	Yes	No	Yes	No	Yes	No

Secondary Wood Products:	Rarely………………………Often			Information or Expertise		Labor or Equipment		Finances	
30.	1	2	3	Yes	No	Yes	No	Yes	No
31.	1	2	3	Yes	No	Yes	No	Yes	No
32.	1	2	3	Yes	No	Yes	No	Yes	No
33.	1	2	3	Yes	No	Yes	No	Yes	No
34.	1	2	3	Yes	No	Yes	No	Yes	No

Business / Organization / Group	How often do you interact? 1=Rarely (1-2 times a year) 2=Occasionally 3=Often (once a month or more)			Do you exchange resources?					
				Information or Expertise		Labor or Equipment		Finances	
Secondary Wood Products (cont.):	Rarely…………………….Often								
35.	1	2	3	Yes	No	Yes	No	Yes	No
36.	1	2	3	Yes	No	Yes	No	Yes	No
37.	1	2	3	Yes	No	Yes	No	Yes	No
City Government:	Rarely…………………….Often			Information or Expertise		Labor or Equipment		Finances	
38.	1	2	3	Yes	No	Yes	No	Yes	No
39.	1	2	3	Yes	No	Yes	No	Yes	No
40.	1	2	3	Yes	No	Yes	No	Yes	No
41.	1	2	3	Yes	No	Yes	No	Yes	No
42.	1	2	3	Yes	No	Yes	No	Yes	No
Energy / Waste Sector:	Rarely…………………….Often			Information or Expertise		Labor or Equipment		Finances	

	Rarely………Often			Information or Expertise		Labor or Equipment		Finances	
43.	1	2	3	Yes	No	Yes	No	Yes	No
44.	1	2	3	Yes	No	Yes	No	Yes	No
45.	1	2	3	Yes	No	Yes	No	Yes	No
46.	1	2	3	Yes	No	Yes	No	Yes	No
Non-Profit / Volunteer Organizations:	**Rarely……………………Often**			**Information or Expertise**		**Labor or Equipment**		**Finances**	
47.	1	2	3	Yes	No	Yes	No	Yes	No
48.	1	2	3	Yes	No	Yes	No	Yes	No
Other:	**Rarely……………………Often**			**Information or Expertise**		**Labor or Equipment**		**Finances**	
50.	1	2	3	Yes	No	Yes	No	Yes	No
51.	1	2	3	Yes	No	Yes	No	Yes	No
52.	1	2	3	Yes	No	Yes	No	Yes	No
53.	1	2	3	Yes	No	Yes	No	Yes	No
54.	1	2	3	Yes	No	Yes	No	Yes	No

15) **Of those you selected, please identify up to 5 businesses and organizations that are most important to your work?** *(Please list in order of importance, 1=most important)*

Business / Organization / Group
1.
2.
3.
4.
5.

16) **If EAB becomes more widespread in Iowa, which types of businesses or organizations would you expect to collaborate with that you currently are not?** *(Please check all that apply)*

☐ A. I don't expect to collaborate with new businesses because of EAB

☐ B. Tree Service / Arborists

☐ C. Tree Nursery / Landscaping / Tree Farm

☐ D. Sawmill / Lumber Company

☐ E. Professional Forester

☐ F. Firewood Dealer

☐ G. Primary Wood Byproducts (animal bedding, mulch, etc.)

☐ H. Secondary Wood Products (doors, windows, cabinets, etc.)

☐ I. Volunteer Organization / Non-Profit Organization

☐ J. Power / Energy Sector

☐ K. City government / Tree board / Parks and rec.

☐ L. Waste facility

☐ M. Don't know

☐ N. Other (please describe):_____

17) **We are interested in learning more about those who you look to as <u>leaders</u> in tree management or wood utilization in your community? Please identify all businesses, organizations, or individuals that you consider to be leaders.** *(Include yourself, if applicable)*

18) We are interested in learning more about those who are <u>innovators</u> (e.g., those who come up with new ideas, techniques, or processes) in tree management or wood utilization in your **innovators.** *(Include yourself, if applicable)*

19) We will host a workshop in Dubuque in April 2012, to bring those interested in addressing the spread of EAB and wood utilization opportunities together. We would like to know more about topics that may be of interest to you. (*Please check all that apply*)

☐ B. Wood products manufacturing and marketing options for Ash trees and EAB infested wood

☐ C. Understanding EAB management and control techniques

☐ D. EAB monitoring tools and opportunities

☐ E. Opportunities to help homeowners and communities prepare and manage EAB

☐ F. Planning for a diverse urban tree community

☐ G. Other:_____

☐ H. Other:_____

20) Would you be interested in attending our workshop, with the topic area of managing for EAB and wood utilization?

<div align="center">Yes   /   No</div>

21) Please provide any additional comments:

Please provide contact information so we can keep in touch about workshops and share findings.
Name:
Phone:
Email:
You are done! Thank you very much for your help with this important survey. If you have any questions, please contact the Project Coordinator, Justin Landhuis; landhuis@iastate.edu, 515-294-9845, or the Project Supervisor, Dr. Tricia Knoot; tknoot@iastate.edu; 515-294-7344). Thank you!