THE NATIONAL PICTURE OF NONNATIVE PLANTS IN THE UNITED STATES ACCORDING TO FIA DATA

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Abstract.—Data collected by the U.S. Forest Service Forest Inventory and Analysis Program was assembled from each region of the United States. Occurrence, measured as the percentage of forested subplots within a county with observed nonnative invasive plant (NNIP) species, was calculated across the continental United States and Hawaii. Each region, and in some cases each state, maintains a specific watch list to constrain monitoring to only the most important NNIP species within a given area. Therefore, occurrence is based on regionally important species and is inconsistent across the United States. NNIP can be found invading forests across all of the United States. Eastern U.S. forests, however, currently exhibit high levels of NNIP occurrence. Major U.S. travel corridors and areas of considerable forest fragmentation that are often coupled with the large human population in the eastern United States can be important drivers of NNIP distributions. Travel corridors are known to play a profound role in the spread and growth of invasive plants. That fact is evident in maps of NNIP species where many major U.S. interstates are apparent. For example, the I-85 corridor from Virginia to Alabama is an area of intense invasive plant abundance. When forests are divided into smaller and smaller parcels (fragmented), the biological diversity of native animals and plants is diminished, water cycles are altered, and often nonnative invasive plants are introduced. This could help explain the high degree of plant invasions in the heavily agriculture dominated landscapes of the middle southern and middle western United States.

INTRODUCTION

Invasive plants in the United States are an expensive problem both economically and environmentally. In their last update on the economic impact of invasive species (plants and other organisms) in the United States, Pimentel et al. (2005) suggest that the cost of prevention and eradication of nonnative invasive plant (NNIP) species in crop, pasture, and forest settings is approximately $27 billion every year. In fact, the cost of combating just the invasive tree *Melaleuca quinquefolia* in the state of Florida was estimated at between $3 and $6 billion dollars in 2005 (Pimentel et al. 2005).

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The environmental impacts of nonnative invasive plants are hard to quantify. Many impacts are difficult or impossible to measure in the field or to directly attribute to NNIP because of the relative lack of controlled experiments related to NNIP and the complexity of co-occurring NNIP. For example, most invasion biologists accept that NNIP cause disruptions in the ecological systems they inhabit, whether by directly altering soil chemistry (e.g., Chinese tallowtree [*Triadica sebifera*]) (Bruce et al. 1995, Cameron and Spencer 1989), through competition with native species (e.g., Japanese honeysuckle [*Lonicera japonica*]), or by hindering regeneration in forested settings (e.g., Nepalese browntop [*Microstegium vimineum*]) (Oswalt et al. 2007). However, while widely acknowledged, the environmental costs of those impacts have not been quantified in a consistently applied manner that can be scaled up for the nation. Additionally, we are just now beginning to recognize the need for valuation of ecosystem services, biodiversity, and aesthetics, and therefore would be hard-pressed to place a dollar value on the environmental impacts even if we were able to directly measure and sum them nationally. Many of the environmental impacts of NNIP may be secondary and virtually impossible to quantify. For example, the secondary impacts of herbicides used to control NNIP or the secondary impacts of altered regeneration pathways on wildlife species that use affected forests cannot easily be measured.

One step towards a better understanding of the impacts of NNIP at the national level is the task of identifying where invasive species occur on forest land. Monitoring plants known to be potentially invasive in forested environments enables land managers and policymakers to identify "hotspots" where efforts for eradication and control might be concentrated. Monitoring the same species over time can help to identify species that are expanding in extent versus species that have reached a stasis. Monitoring may also help to identify some species that have spread to the point that extirpation could be considered a futile effort, and thus resources can be directed at efforts that might lead to more success. Finally, collecting NNIP data in conjunction with forest inventory data can shed light on the environmental factors contributing to the invasibility of particular sites, as well as allowing for some understanding of the potential relationships between the presence or absence of NNIP and the biodiversity of the site in question.

Given the importance of monitoring NNIP on U.S. forest land, regions in the Forest Inventory and Analysis Program of the U.S. Forest Service have implemented efforts to track NNIP. Previous efforts by individual regions have been unique and specific to those units, thus no consistent method for identifying and tracking NNIP has been applied nationwide (Rudis et al. 2004). Efforts are underway to establish some modicum of consistency in measurement; however, for this paper we use data collected and compiled by each regional office. Our objectives were to map NNIP nationwide and report spatial patterns observed as a result of the compilation and mapping effort. Additionally, we discuss difficulties in evaluating invasive species at a national scale.

METHODS

Data collected by the U.S. Forest Service Forest Inventory and Analysis (FIA) Program were assembled from each region of the United States. Occurrence, measured as the percent of forested subplots within a county with observed NNIP species, was calculated across the continental United States and Hawaii. Each region and, in some cases, each state maintains a specific watch list to constrain monitoring to only the most important NNIP species within a given area. Therefore, occurrence is based on regionally important species and is inconsistently measured across the United States.

The data used in the analysis spans 1999 to 2010, depending on the state and region. Data from the Pacific Northwest were collected from 1999 to 2009, though data from Alaska spans 2004 to 2009 and data from Hawaii were collected in 2010. Data from the Intermountain West spans 1999 to 2009 while northern data were collected from 2007 to 2010 and southern data were collected from 2001 to 2010.

Each region uses a distinct program for collecting invasive species data, though plans are underway to provide a nationally consistent method for future surveys. For this paper, data collection methods differed by region and, in some cases, state. Data were normalized to minimize differences between regions by calculating the number of forested subplots present in a county, the number of forested subplots with at least one invasive species present, and by generating a "percent invaded" statistic so that counties across the country could be compared in a consistent manner. County and regional comparisons are based on visual observations of mapped data. Rudis et al. (2004) describe data collection methods for the various regions, and specific data collection details are available through the FIA website at http://www.fia.fs.fed.us/library/field-guides-methods-proc/.

RESULTS AND DISCUSSION

The percentage of forested subplots containing one or more NNIP was highest in the North Central, Northeast, and South Central subregions of the United States with invasives affecting 56, 48, and 45 percent of subplots, respectively (Fig. 1). The Intermountain region had the smallest proportion of subplots with NNIP at 5 percent. In general, forested subplots east of the Mississippi River had higher incidences of invasive plant occurrences than those in the western half of the country (Fig. 2).

Concentrations of invasive plants appear in areas dominated by agriculture including the delta region of the Lower Mississippi Valley in Arkansas, Mississippi, and Louisiana, as well as along the I-85 travel corridor from Virginia to Alabama, the bluegrass region of Kentucky, heavily populated areas in the North and Northeast, and the area around Spokane, Washington (Fig. 2). A small concentration occurs along the gulf coast in Texas and Louisiana, which reflects large populations of Chinese tallowtree.

Major U.S. travel corridors and areas of considerable forest fragmentation that are often coupled with the large human population in the eastern United States can be important drivers of NNIP distributions. Travel corridors are known to play a profound role in the

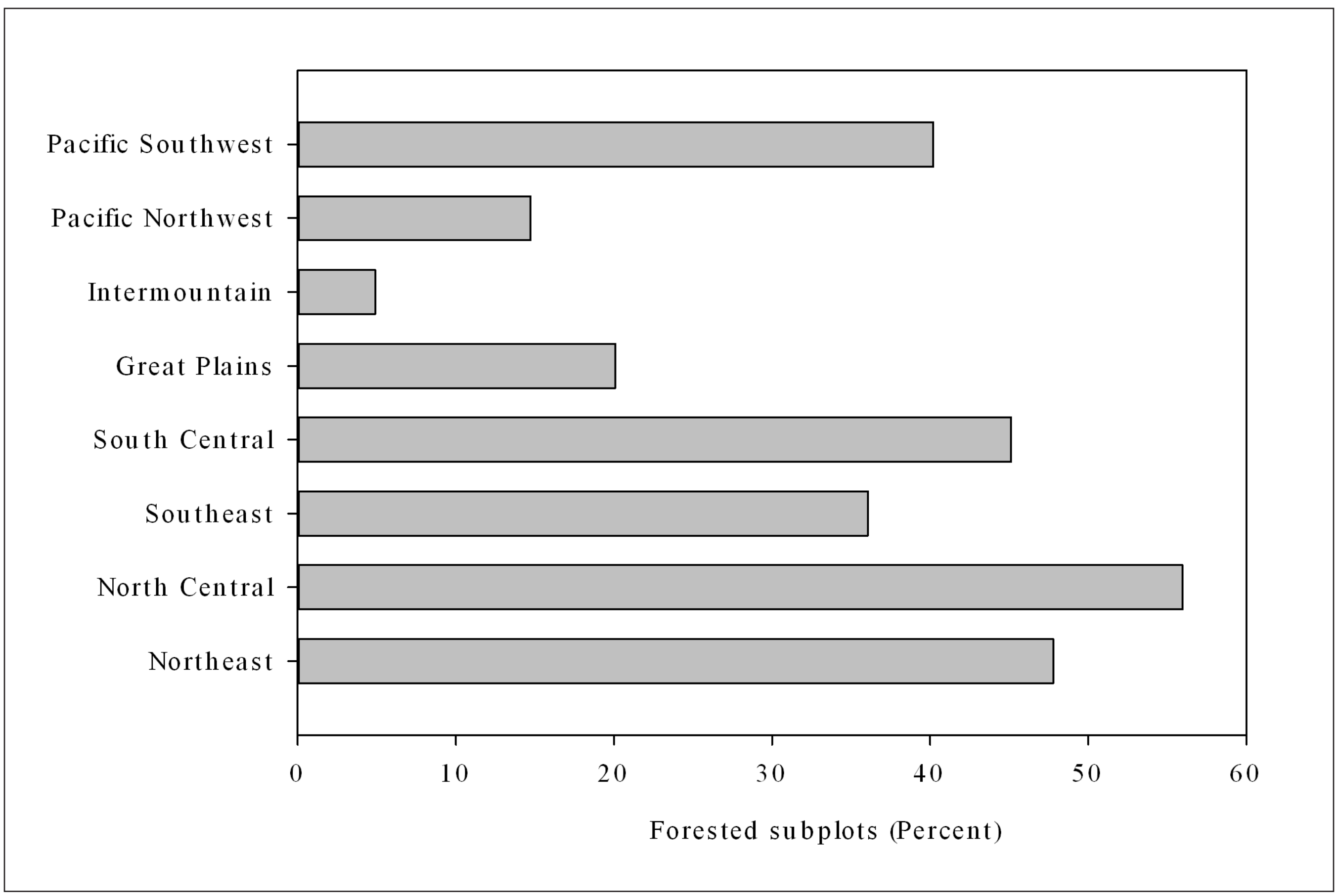

Figure 1.—Percentage of forested subplots containing at least one nonnative invasive plant, by subregion.

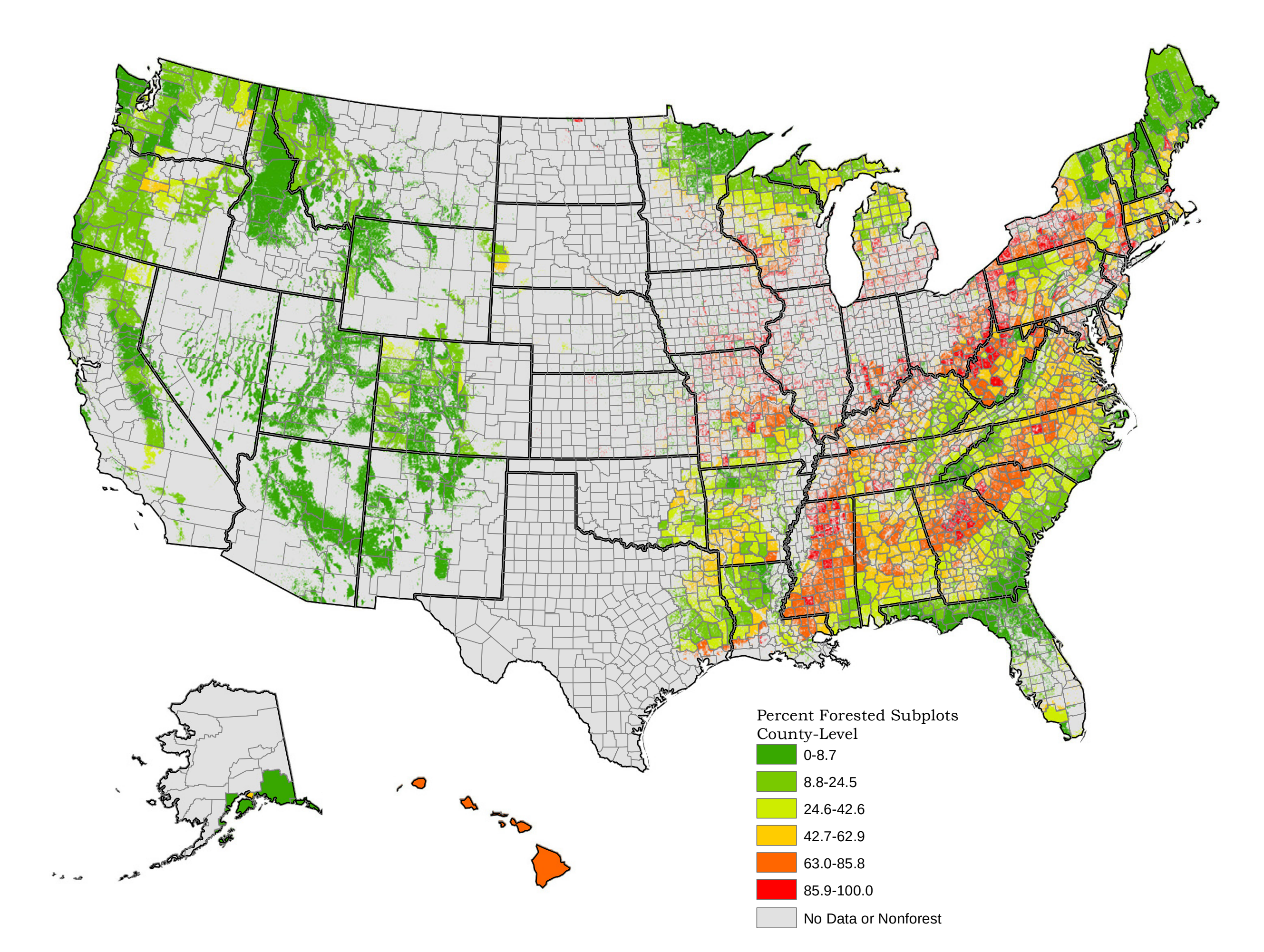

Figure 2.—National map showing percentage of forested subplots with a nonnative invasive plant (NNIP), calculated at the county level. Forest/nonforest mask applied to the contiguous 48 states.

spread and growth of invasive plants. When forests are divided into smaller and smaller parcels (fragmented), the biological diversity of native animals and plants is diminished, water cycles are altered, and often nonnative invasive plants are introduced. This could help explain the high degree of plant invasions in the landscapes of the midsouth and midwest United States that are heavily dominated by agriculture.

In the southern United States, much of the noted occurrence of NNIP on forested land is due to the ubiquitous presence of Japanese honeysuckle and nonnative privets (*Ligustrum* L.), particularly at the forest edge. When Japanese honeysuckle is removed from analysis, the NNIP situation in the south looks far less dire, and hotspots of other species are detectable (Fig 3). In the northern region, the presence of nonnative roses (*Rosa* spp.) accounts for much of the widespread invasion. In the Pacific Northwest, cheatgrass (*Bromus tectorum*) is fairly ubiquitous. Thus, one question this map and brief analysis raises is, should we continue to monitor NNIP that are so ubiquitous as to be considered naturalized and that we have no realistic expectation of exterminating from the system, and does the overwhelming presence of those species mask evidence of other invasions? From a budgetary standpoint, is it cost effective to continue to monitor such ubiquitous species, or should monitoring dollars be focused on species that are less common now, but are considered very likely to become problematic in the future? At the very least, it is worth considering removing ubiquitous species from

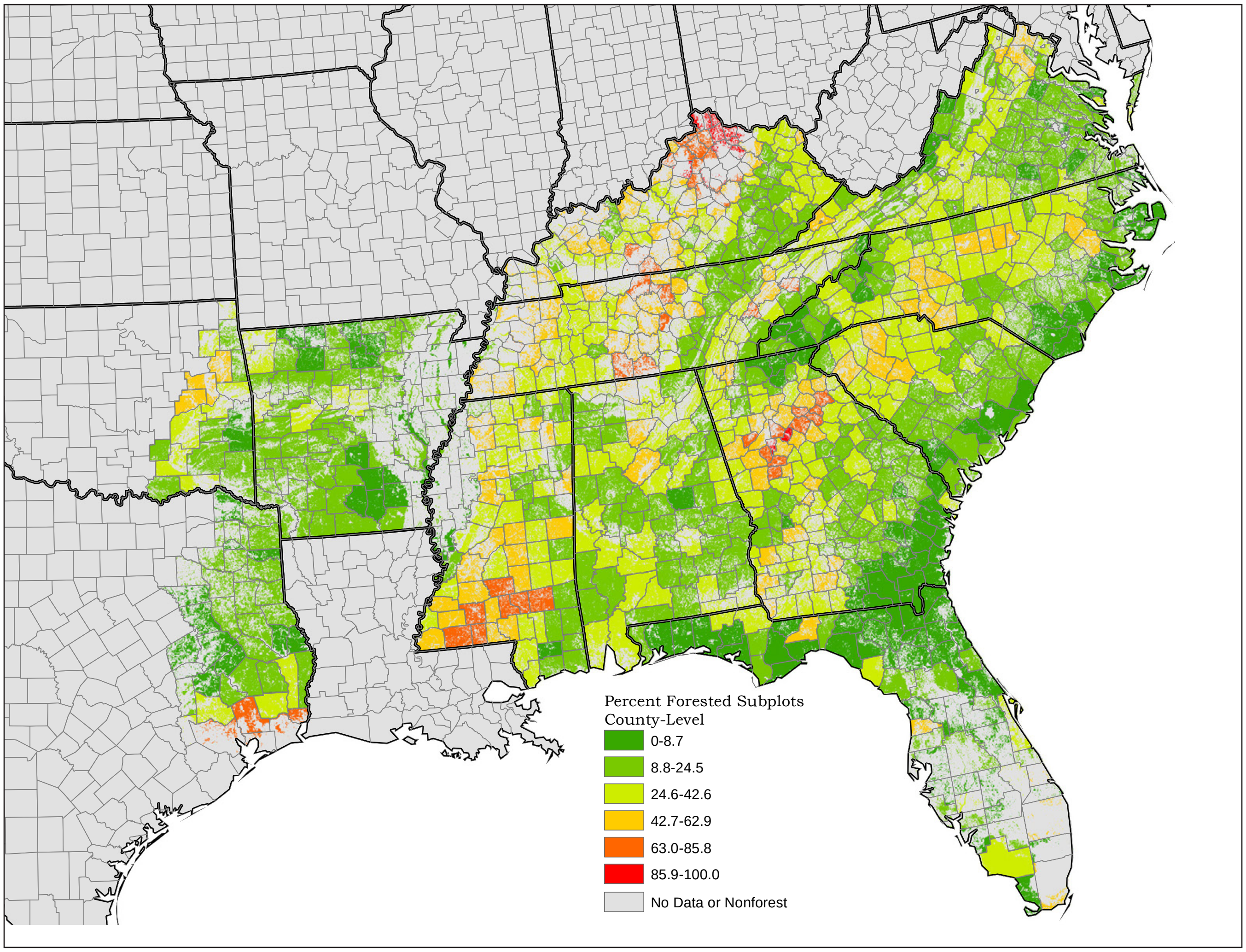

Figure 3.—Map of the southern United States showing the percentage of forested subplots with a nonnative invasive plant (NNIP), excluding Japanese honeysuckle, calculated at the county level. Forest/nonforest mask applied to the contiguous 48 states. Data from Louisiana was unavailable at the time of analysis.

analyses in order to uncover potentially more “telling” patterns.

Differing methods between regions limit the conclusions that may be drawn from a national map, and given differences in physiography and climate, perhaps the national scale isn’t the best scale for evaluating nonnative invasive plants. Establishing consistency in methodology should help. However, an overview like this does give an indication of where particularly problematic areas exist and gives national leaders the opportunity to review where prevention education and eradication dollars might be best spent. Thus, as we move forward with the FIA invasive species program, it will be continually important to discuss whether the species we are monitoring are the plants most worthy of our time and money, if we are answering the questions we set out to answer with the program, and finally, how we can use this information to make forward progress in combatting the negative impacts of invasive plants in our forests.

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