The Political Ecology of Forest Health in the Redwood Region[1]

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Abstract

Imported forest pests have changed North American forests and caused staggering monetary losses in the centuries since the country was founded. Since most problem-causing non-native pests are innocuous in their home ranges, where they have coevolved with their host trees, experts cannot predict which pathogens or insects will have lethal effect on other continents. Many non-native pests are unknown to science until they cause problems in their new homes. One common response to the threat of non-native insects and diseases in our forests is to appeal to science to develop technical means for management or eradication, yet common sense tells us that it would be more cost-effective and ecologically efficient to prevent pest introductions in the first place. The discipline of political ecology explores the ways in which many environmental issues that are usually presented as scientific or technical problems are actually policy issues that have been redirected into scientific discussion in order to avoid acknowledging the need for hard political choices. The political ecology of forest pest management is very relevant to 21st-century forestry in the redwood (*Sequoia sempervirens* (D. Don) Endl.) region, where we have no way of knowing whether the next pest will be the one to target redwood or another native California tree species. These questions are especially important to consider and to educate policymakers about in California, where the iconic coast and Sierra (*Sequoiadendron giganteum* (Lindl.) Buchholz) redwoods have limited distributions that may make them vulnerable to future pest invasions.

Introduction

The process of globalization begun 5 centuries ago continues to intensify, as communication, physical travel, cultures, and markets integrate themselves more tightly. In the United States, political debate plays out over the proper role and scale of American engagement, but in one way or another involvement with overseas friends and enemies shapes nearly all American lives at the most personal levels. This involvement shapes the physical environment as well. Not only do Americans extract resources for export, but they also bring in living organisms from across the globe, and some of these organisms have the potential to remake both physical landscapes and biotic communities. No kingdom of life, from the smallest prokaryote to the tallest redwood tree, is entirely immune to this reshaping.

Non-native invasive species (NNIS) cause devastating economic losses to individuals and communities, and devastating ecological losses to forests, every year. Pimentel et al. (2005) estimated that the costs of NNIS in the United States alone amounted to nearly $120 billion per year and that 42 percent of species listed as threatened or endangered were imperiled primarily because of non-native, invasive competitors or predators. Losses attributed to NNIS include impacts to wildlife dependent on specific plant species; increases in wildfire hazard as trees die and become part of the fuelbed; hazards to human life and infrastructure from falling trees; loss of tree species that are culturally and spiritually important to specific communities; aesthetic degradation; loss of amenity values provided in urban and individual home settings; and nuisance impacts to water supplies, roadways, and houses.

The first-world practice of unintentionally bringing exotic organisms ashore has changed the ecology of world forests. Some of these changes have happened more or less quickly and disruptively, some more slowly and subtly. *Phytophthora cinnamomi*, an oomycete pathogen

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probably moved from southeast Asia, has reduced entire forests of jarrah (*Eucalyptus* spp., with tree, shrub, and grass associates) to barrens (Weste 2003, Weste and Marks 1987)—an example of a disruptive change. On the more subtle end of the scale, the pine-infecting decay fungus *Heterobasidion irregular*, was probably introduced by United States troops to Italy during World War II, since when it has been slowly expanding in range and appears to be outcompeting the native pathogen *Heterobasidion annosum*, a process that requires genetic analysis to trace fully (Gonthier et al. 2007).

Understanding the biological processes of these invasions, and their impacts, has required scientific expertise. The task of dealing with the impacts has inspired numerous scientist-led coalitions for pest management in invaded forests (some examples: Save the Ash Tree Coalition, California Oak Mortality Task Force, O'ahu Invasive Species Committee, Dieback Working Group, Continental Dialogue on Non-Native Forest Insects and Diseases, National Invasive Species Council—not to mention those dealing with non-forest or non-plant pests). Although these groups have not been comprised of scientists exclusively, but have also included plant care professionals, politicians, concerned citizens, and landscape managers, by and large they have looked to those with extensive scientific training to lead their efforts. Problems involving forest pests are among the natural resources management issues for which university extension programs and management agency personnel increasingly invoke the need for "science-based information" to satisfy a need for objectivity among competing public and private claimants.

Although technical expertise is clearly required to identify NNIS, to understand their biology, and to develop management technologies for tree and forest protection once NNIS are present on the landscape, there are numerous steps along the pathway of forest pest management that depend not on scientific understanding, but rather on political decision-making. Appealing to the authority of science can often be a potent way for decision-makers to mask the political nature of decisions that affect the environment, or to hand off responsibility for making those decisions. Exposing the politics behind these decisions and quantifying their environmental effects is the domain of the hybrid academic discipline called political ecology (Robbins 2004). This paper brings the political ecology project to pest management in the coast (*Sequoia sempervirens* (D. Don) Endl.) and Sierra (*Sequoiadendron giganteum* (Lindl.) Buchholz) redwood regions by seeking to demystify the role of science in invasive species and forest health protection and pointing out some of the ways in which science-based decision-making, to be effective, should be supported by moral awareness, place-based argument, and political action. Without intending to fear-monger, we use examples from California and beyond to argue that we must recognize the interplay between politics and science as it underlies forest pest management if we want to prevent future invasions of NNIS that could extirpate iconic tree species in the redwood region—perhaps even redwood itself.

Pest Exclusion

It helps to look at management of NNIS in two distinct phases: pre-invasion and post-invasion. We can call pre-invasion management practices "exclusion" and post-invasion practices "management." Management involves a myriad of possible actions, including eradication, prophylaxis, containment, slowing the spread, resistance breeding, and others. Exclusion, on the other hand, involves just a few practices, such as legislation, inspections, and pest destruction. Although common sense tells us that the most effective means of NNIS management consists of preventing them from arriving and establishing in the first place, we don't have to depend on common sense: we have numerous convincing examples of the costs of failing to do this. Chestnut blight, caused by *Cryphonectria parasitica*, arrived in the United States in 1904 and within 50 years had completely wiped out mature chestnut (*Castanea dentata* (Marsh.) Borkh.) stands throughout the eastern United States (Anagnostakis 1987). Other devastating non-native insect and pathogen pests in United States forests include Dutch elm disease (caused by *Ophiostoma ulmi*), sudden oak death (SOD; caused by *Phytophthora ramorum*), emerald ash borer (*Agrilus planipennis*), white pine blister rust (*Cronartium* *ribicola*), hemlock wooly adelgid (*Adelges tsugae*), and Port-Orford-cedar root disease (caused by *Phytophthora lateralis*). Although individual management actions can spot eradicate, slow the spread, or contain NNIS after arrival, costs and manpower are usually astronomical and often prohibitive (Moser et al. 2009)—especially when compared to the costs of heading non-native pests off at the port.

Despite the advantages of a proactive, exclusionary stance toward NNIS, the American system of pest exclusion is anemic. A strong system of exclusion would enable countries to engage in what economists disparagingly call "protectionist" activities, e.g., to reject materials strongly suspected of or shown to be harboring NNIS. This would require a framework of laws that enable flexibility in import inspection and rejection, including outright forbidding of particular types of goods considered extremely high-risk for NNIS, such as container-grown plants in growing media or wood packaging materials. Moreover, a strong exclusionary system would prioritize the inspection process by providing adequate facilities and personnel to oversee the process. The United States, like many other modern countries, has elected to do very little of this. In general, the American plant inspection and exclusion system is plagued by a paucity of plant protection staff, an insufficient number of pest inspections performed, low pay for inspection personnel, and insufficient equipment and facilities for plant species holding and identification (Reaser and Waugh 2007). Simberloff (2006) mentions this underbudgeting as a key reason for certain U.S. Department of Agriculture, Animal and Plant Health Inspection Service (USDA APHIS) functions having been transferred to the Department of Homeland Security, even though this did not solve the problem. McCullough et al. (2006), citing National Research Council (2002), point out that only 2 percent of high-risk cargo targeted for inspection each year can be inspected by APHIS personnel.

Beginning in the 20th century, and particularly during the past 20 years, the United States corporate capitalist class has collaborated in the creation of a system of global "free" trade that valorizes porous borders and penalizes protectionism in any form. Many political economists call this laissez-faire capitalistic economic philosophy "neoliberalism"; although the term covers a wide range of possible economic, political, and philosophical developments and should be used with caution, its general ideas as widely understood today underlie such economic innovations as free-trade zones, fiscal austerity, World Bank and International Monetary Fund-imposed structural adjustments, and extensive market-oriented deregulation (Boas and Gans-Morse 2009, Harvey 2005). In terms of pest exclusion, the most damaging such innovation has been the gradual eclipsing of American authority to regulate potentially harmful imports through quarantines and inspections by the ascendancy of the principle of non-interference with trade. In 1912, the introduction of white pine blister rust stimulated the U.S. government to formulate the Plant Quarantine Act, which established federal control over inspections and sanitary measures related to the movement of plants and animals into and out of the country and between states (Aukema et al. 2010, Weber 1930). This act was modified and held in force as "Quarantine 37" for most of the 20th century, giving the government wide latitude over rejection of potentially harmful imported materials, but the formation of the World Trade Organization (WTO) in 1990 began its *de facto* dismantling.

Article 5, no. 4 of the Agreement on the Application of Sanitary and Phytosanitary Measures by the WTO, negotiated in Uruguay and ratified in 1994, subjects all environmental protection considerations to the principle of non-interference with trade. Members have the "right" to develop phytosanitary measures, but only so long as they are consistent with the agreement, which generally states that, should the need for phytosanitary measures arise within any two member states, the members must bilaterally agree on the scope and substance of the measures. There are exceptions to the articles for urgent situations, but these exceptions cannot be extended indefinitely. Moreover, to implement such an exception, members cannot justify the exception politically or morally, i.e., with an appeal to a precautionary principle for environmental protection. Such an appeal is interpreted by the WTO as a "disguised restriction" on trade. Rather, members must marshal scientific evidence supported by a formal risk assessment in order to implement emergency phytosanitary measures. The onus of proof that such measures are necessary falls upon the receiving, not the exporting, country. It is interesting to note that the agreement is built on a political priority (free trade), but the political nature of this preference is couched as an appeal to an apolitical authority (science) (World Trade Organization 1994).

One of the original assumptions of Quarantine 37 was that imported stock would only be used to establish domestic propagation operations, not for direct resale. But under the 1994 Agreement, this practice is a disguised restriction on trade. Therefore, the United States cannot require that only seed be imported for development of ornamental plant stock or that all ornamental plant stock be propagated and grown within United States borders. WTO rules also prevent the United States from keeping a “black list” of plant genera that are known to be associated with dangerous pests or groups of pests, although some WTO member countries, such as Australia, have been willing to court WTO disapproval by maintaining such lists (Keller et al. 2007). Recently, APHIS has developed a gray list of plants that are provisionally banned pending further study (Liebhold et al. 2012), but in general, the United States has not been willing to maintain any black lists.

As the above example shows, governmental adherence to the WTO-controlled phytosanitary system varies from country to country, even among WTO members. Using examples from the United Kingdom and Australia, Keller et al. (2007) show that phytosanitary strictness and laxness even varies within the same country according to commodity. In Australia, for example, domestic apple producers have been successful at restricting apple imports from New Zealand because the bacterial disease fire blight is found in New Zealand apple orchards but not in Australia, whereas Australian beef producers were not ultimately successful in securing wide-ranging restrictions on beef imports from the United States even when concern about mad cow disease (present in the United States) was very high in Australia. According to Maye et al. (2012), these cases exemplify the asymmetry of global economic power relations, showing that phytosanitary measures may be based upon objective science, but tend to stray from it depending on how the regulating country construes the economic risks and opportunities that hinge on these measures—a balancing act between neoliberal economic development and biosecurity. Indeed, this pairing of cases is an extreme example. Because mad cow disease presented a potent human health threat, the contrast between Australia’s weak position on excluding beef imports from the dominant world power and its strong position regarding excluding apple imports (not a human health threat) from a complacent regional partner amply demonstrate the ascendancy of geopolitical considerations over domestic biosecurity.

Insufficiency of Science

Scientific expertise is clearly necessary for the formulation of effective phytosanitary measures, but it is also clearly insufficient. Although the formal risk assessment procedure mandated by the WTO may initially seem reasonable as an adjudicator of whether stringent exclusion measures are necessary, these assessments often take too long (sometimes years) to make them meaningful. Pest risk assessments can give an idea of a pest’s likelihood of establishment in a non-native environment, and sophisticated modeling can often predict post-establishment NNIS spread with surprising precision, but these assessments do not, as a rule, balance competing economic interests or account for so-called “externalized” environmental costs such as the cascading ecological effects of the extirpation of a keystone plant species, aesthetic losses, or spiritual losses (Brasier 2008, Perrings et al. 2005).

Moreover, many non-native forest pests are unknown to science until they have already become established and are causing damage in their new homes (Brasier 2008, Roy et al. 2014). This was the case, for example, for two newly introduced and extremely destructive forest insects from eastern Asia, polyphagous shot hole borer and Kuroshio shot hole borer (unnamed species of *Euwallacea*), which were unknown before entering southern California, where they have decimated extensive stands of riparian hardwood trees (Boland 2016). It was at first assumed that both insects were the tea shot hole borer, *Euwallacea fornicatus*, until extensive genetic study well into the insect outbreak determined that they are actually related, separate species. Many pest species may not be harmful in their home ranges, where they have co-evolved with their host trees and cause only minor, inconspicuous damage. This is the case with *P. lateralis,* an oomycete pathogen responsible for extensive mortality of Port-Orford-cedar (*Chamaecyparis lawsoniana* (A. Murr.) Parl.) in California and Oregon. This pathogen was first found in the United States in 1923, but was only traced to its probable center of origin in 2010, when it was discovered in Taiwanese forest soils with a close relative of Port-Orford-cedar (Brasier et al. 2010). In each of these cases and many others, a fully developed scientific understanding of the pest, its damage potential, and its pathways of introduction did not emerge until well after the pest had become established in the United States. In the case of the southern California shot hole borers, this knowledge is still developing, and there is nothing to suggest that these boring beetles will not spread northward through the state. These examples demonstrate the reactive nature of current plant pest detection systems: when the burden of examining pests is postponed until they escape, establish, and cause a problem, the receiving country's natural environment becomes, over and over again, a *de facto* laboratory for large-scale, uncontrolled experiments in pest pathogenicity, aggressiveness, and/or virulence.

All phytosanitary measures are based on acceptable risk, since no government can spend the money or time required to exclude or inspect every traded article. It is clear from the above examples that basing pest exclusion measures on scientific considerations without adducing additional political or moral concerns as part of biosecurity regimes poses a very high level of risk. As an additional example, consider the case of Native American tribes in northwestern coastal California, whose ancestral lands are being invaded by *Phytophthora ramorum*. To these tribes, the acorns of tanoak (*Notholithocarpus* d*ensiflorus* (Hook. & Arn.) P.S. Manos, C.H. Cannon, & S.H. Oho), the primary susceptible host tree, have provided a principal food source for thousands of years (Bowcutt 2013), and tanoak along with other plants that host this pathogen have great spiritual importance—unlike traditional natural resource extraction markets, which recognize tanoak as a species that competes with valuable timber trees (Alexander and Lee 2010b). Although this spiritual and foodway importance is widely if informally recognized, this recognition has not enabled the tribes to garner additional money or efforts to fight the pathogen. The California and United States governments primarily provide environmental protection by regulating formalized intra-and interstate commercial activities such as timber harvesting and agriculture. No California agency is tasked with proactive intervention, especially based on spiritual or quality of life concerns, to alleviate forest degradation across administrative boundaries. It may be that most world governments that participate in the current free-trade system are comfortable with this kind of risk, in which vulnerable constituencies who locate value elsewhere than in the market suffer damage because of economically- and scientifically-based decisions made elsewhere. But such risks do not only pertain to the exclusion phase of pest management; the insufficiency of science as a guide to action extends also to post-invasion biosecurity measures.

Political Complexities in Post-invasion Management

This paper has concentrated on the politics of pre-invasion pest management (pest exclusion), but we should briefly mention the many non-scientific factors that determine the success or failure of post-invasion pest management efforts. These include the following:

1. *Funding*. Nothing articulates environmental priorities, and lays bare their essentially political nature, quite so loudly as a government budget. In California alone, numerous trade and public safety priorities trump forest health protection. Whether this is good or bad is immaterial; we simply point out that this priority ranking is essentially based on moral, economic, or social considerations, not on science.
2. *Time*. The grant funding and money appropriation mechanisms that underlie most pest management activities do not lend themselves either to the quick response that is necessary to eradicate most pests before they become established in an area or to the long-term, persistent efforts necessary to contain pest species after they become established in an area. Although much

of this is inspired by an ethos of good stewardship of public funds, it also displays to some extent the capriciousness of public opinion about biological emergencies. For example, in 2009-2010 alone, the California Department of Forestry and Fire Protection allocated $519 million to the base budget for fire operations, with an extra $182 million emergency "overflow" budget (Donald 2009); for SOD, a generous estimate over the decade-long research and management programs budgeted by both federal and state agencies up to that point—exclusive of USDA APHIS's considerable budgetary allocation—is 30 to 50 million dollars (Alexander and Lee 2010b). A stable and extensive funding base enables a focus on quick emergency response in the case of wildfire, and it has enabled the development of a vast wildfire response infrastructure of people and equipment. Both situations represent biological emergencies warranting extreme concern; both threaten human infrastructure and human life; but the differences in time scales and visibility between them assure that only one assumes a dominating position in the minds of most Californians.

3. *Territory*. Forest pest management success often depends on who controls legal, bureaucratic, and social territory. For example, the California Department of Food and Agriculture was unable to deploy mating disruption treatments to control the light brown apple moth, which feeds on many different kinds of trees, because a very vocal and politically influential public in the San Francisco Bay area interpreted these treatments as chemical pesticides (Garvey 2008)—an example of government's losing control of the social territory surrounding forest health and chemical use. As another example of the power of controlling discursive territory, SOD largely gained attention as a problem because it first appeared near the homes of affluent communities with expertise in leveraging their local, state, and national political representation (Alexander and Lee 2010b). This extends to geographic territory as well, where the success of pest control often depends on the willingness of landowners to engage with the problem. Politically-determined geographic boundaries often over- or under-regulate pests, and arbitrarily or historically drawn boundaries are usually not appropriately matched to the scales of NNIS invasion and spread (Thompson et al. 2016).

The Coast Redwood Region: a Case Study

The forests of California's north coast (and southwestern Oregon) suffered several major forest pathogen invasions in the 20th century, including *P. lateralis* in the 1950s (Zobel et al. 1985), *Fusarium circinatum* (cause of pitch canker) in the 1980s (Camilli et al. 2013), and *P. ramorum* in the 1990s (Rizzo et al. 2005). More recently, as mentioned earlier, several different species of bark and ambrosia beetles have invaded southern California forests and are poised to move northward throughout the ranges of their various hardwood hosts. The *Phytophthora* invasions to California have been linked to the trade in ornamental plants, while pitch canker arrived from the southeastern United States via an unknown route. In most of these cases, the invaders were unknown to science prior to the invasion, and large amounts of money and time have gone into biological study and adaptive management trials. The appearance of these invaders testifies to the risks presented to California's forests by their exposure to its large urban centers and intensive economic activities. In all cases, there has been fear that pathogen presence over a long enough period of time will result in the extirpation of the pathogen's primary host (for *P. lateralis*, Port-Orford-cedar; for *F. circinatum*, native stands of Monterey pine; for *P. ramorum,* tanoak and coast live oak [*Quercus agrifolia* Née]), although further study has revealed unexpected pockets of survival and the presence of resistance among some host populations.

The moist microclimates present within the coast redwood belt and extending to the ocean present a generally favorable environment for these non-native pathogens to survive and spread. Importantly, each pathogen infects host trees of secondary economic importance, and so the invasions have not yet stimulated the kind of widespread political action that would lead to changes in the established exclusion protocols or augmentation of infrastructure and personnel at either the national or state border inspection facilities. Political ecologists would call attention to (1) the ecological damage caused by the loss of rare species (e.g., Port-Orford-cedar) and keystone species (e.g., tanoak) as well as to (2) the ways in which the current prioritization of economic importance has marginalized the communities of people who depend on these tree species. As mentioned above, although tanoak is known primarily as a competitor to trees managed for timber values and is difficult to manage for timber values itself because of its particular wood properties, it is hard to overstate its importance as a food source and spiritual symbol to northwestern California Native American tribes (Alexander and Lee 2010a).

Even given the gradual diminishment over time of the timber industry's contributions to the California economy, the stately conifers of the redwood belt, especially coast redwood and Douglas-fir, (*Pseudotsuga menziesii* (Mirb.) Franco), are still a foundation resource in many ways: they contribute to economic, aesthetic, recreational, and spiritual values for millions of people. If a NNIS capable of killing these conifers *en masse* were to enter the state, one wonders what the political response would be, and whether this would be enough to catalyze a reconfiguration of the porous United States trading system.

Conclusion

This discussion has offered only the briefest of forays into the complexities of political ecological approaches as they apply to understanding the management of NNIS. As a relatively unified group of thinkers, political ecologists carry their own political affiliations, usually on their sleeves. They tend to be highly critical of neoliberal ideology and capitalism in general, and they try to draw attention to groups that are marginalized when governments use science as a cover for what are really political decisions. We do not have to subscribe fully to the politics behind this approach in order to recognize that it is calling attention to something important: appealing to the objective authority of science as a foundation for environmental decision-making can often be a red herring. In NNIS management, in particular, it is fairly clear that we need a stronger system of plant exclusion and inspection to keep harmful pests within their proper continental and regional borders, yet we continue to avoid dealing with this issue by keeping serious discussion in the technocratic-scientific realm.

We are by no means arguing that scientifically informed post-establishment management is unnecessary; on the contrary, insufficient money and effort is almost always allocated in that direction too. But the case is much more black and white in the case of exclusion than in that of post-invasion management. We believe that national governments need to work harder to find ways to accommodate both robust economic exchange and more thorough inspections/stronger national control of potential pest-carrying imports. At times, some protectionism and some restrictions on trade may be warranted in the service of the integrity of global forests. Drawing these lines is an essentially political activity: the rapid proliferation of a vocabulary of "science-based decisions" and "science-based risk assessments," along with continued dependence on quantitative science as a foundation for decisions and assessments rather than an adjunct to a more general prioritization of environmental principles, show that this is not generally recognized. Nevertheless, until forest managers and scientists do recognize it as such, they will be ill-equipped to participate in the process, or worse, they will be unwitting tools of the political establishment.

This issue should be of direct concern to those who live in regions like California that contain high numbers of endemic plant species. Because of their size and historical importance, coast and Sierra redwoods are rock stars of world forests. It would be a crushing blow to the state if these emblems of California's natural environment—or any of the myriad other compelling and rare tree species that call the state home—were extirpated by a hitherto unknown insect or pathogen hitchhiking from another continent. California is particularly vulnerable to such an invasion because of its major ports of trade and strong economy, as is shown by the problems we already have with invasive pests such as *P. ramorum*, *P. lateralis*, goldspotted oak borer (*Agrilus auroguttatus*), and the shot hole borers. Whatever their opinions may be about these issues (there is no doubt a healthy diversity), we call upon forest managers and concerned citizens throughout the region to intensify and enrich their conversations with state and national administrators and legislators. We think it wise to proactively move this conversation into the political arena by educating our key policy-makers now rather than to wait for another irreversible and devastating pest invasion.

Literature Cited

Alexander, J.; Lee, C.A. 2010a. The social impacts of sudden oak death and other forest diseases: a panel discussion. In: Frankel, S.J.; Kliejunas, J.T.; Palmieri, K.M., tech. coords. Proceedings of the sudden oak death fourth science symposium. Gen. Tech. Rep. PSW-GTR-229. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 280.

Alexander, J.; Lee, C.A. 2010b. Lessons learned from a decade of sudden oak death in California: evaluating local management. Environmental Management. 46: 315–328.

Anagnostakis, S.L. 1987. Chestnut blight: the classical problem of an introduced pathogen. Mycologia. 79: 23–27.

Aukema, J.E.; McCullough, D.G.; Holle, B.V.; Liebhold, A.M.; Britton, K.; Frankel, S.J. 2010. Historical accumulation of nonindigenous forest pests in the continental United States. BioScience. 60: 886–897.

Boas, T.C.; Gans-Morse, J. 2009. Neoliberalism: from new liberal philosophy to anti-liberal slogan. Studies in Comparative International Development. 44: 137–161.

Boland, J.M. 2016. The impact of an invasive ambrosia beetle on the riparian habitats of the Tijuana River Valley, California. PeerJ. 4: e2141.

Bowcutt, F. 2013. Tanoak landscapes: tending a native American nut tree. Madroño. 60(2): 64–86.

Brasier, C. 2008. The biosecurity threat to the UK and global environment from international trade in plants. Plant Pathology. 57: 792–808.

Brasier, C.M.; Vettraino, A.M.; Chang, T.T.; Vannini, A. 2010. *Phytophthora lateralis* discovered in an old growth *Chamaecyparis* forest in Taiwan. Plant Pathology. 59: 595–603.

Camilli, K.; Marshall, J.; Owen, D.; Gordon, T.; Wood, D. 2013. Pitch canker disease in California. Tree Notes No. 32. Sacramento, CA: California Department of Forestry and Fire Protection. 9 p.

Donald, B. 2009. California fires expensive, but state can cover. Insurance Journal. http://www.insurancejournal.com/news/west/2009/08/20/103145.htm. (03 January 2017).

Garvey, K.K. 2008. Plans to control light brown apple moth stir controversy. California Agriculture. 62: 55–56.

Gonthier, P.; Nicolotti, G.; Linzer, R.; Guglielmo, F.; Garbelotto, M. 2007. Invasion of European pine stands by a North American forest pathogen and its hybridization with a native interfertile taxon. Molecular Ecology. 16: 1389–1400.

Harvey, D. 2005. A brief history of neoliberalism. Oxford: Oxford University Press.

Keller, R.P.; Lodge, D.M.; Finnoff, D.C. 2007. Risk assessment for invasive species produces net bioeconomic benefits. Proceedings of the National Academy of Sciences of the USA. 104: 203–207.

Liebhold, A.M.; Brockerhoff, E.G.; Garrett, L.J.; Parke, J.L.; Britton, K.O. 2012. Live plant imports: the major pathway for forest insect and pathogen invasions of the US. Frontiers in Ecology and the Environment. 10: 135–143.

Maye, D.; Dibden, J.; Higgins, V.; Potter, C. 2012. Governing biosecurity in a neoliberal world: comparative perspectives from Australia and the United Kingdom. Environment and Planning A. 44: 150–168.

McCullough, D.G.; Work, T.T.; Cavey, J.F.; Liebhold, A.M.; Marshall, D. 2006. Interceptions of nonindigenous plant pests at US ports of entry and border crossings over a 17-year period. Biological Invasions. 8: 611–630.

Moser, W.K.; Barnard, E.L.; Billings, R.F.; Crocker, S.J.; Dix, M.E.; Gray, A.N.; Ice, G.G.; Kim, M.-S.; Reid, R.; Rodman, S.U.; McWilliams, W.H. 2009. Impacts of nonnative invasive species on US forests and recommendations for policy and management. Journal of Forestry. 107: 320–327.

National Research Council. 2002. Predicting invasions of nonindigenous plants and plant pests. Washington. DC: National Academy Press.

Perrings, C.; Dehnen-Schmutz, K.; Touza, J.; Williamson, M. 2005. How to manage biological invasions under globalization. TRENDS in Ecology and Evolution. 20(5): 212–215.

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

Reaser, J.K.; Waugh, J.D. 2007. Denying entry: opportunities to build capacity to prevent the introduction of invasive species and improve biosecurity at US ports. Gland, Switzerland: The World Conservation Union (IUCN).

Rizzo, D.M.; Garbelotto, M.; Hansen, E.M. 2005. *Phytophthora ramorum*: integrative research and management of an emerging pathogen in California and Oregon forests. Annual Review of Phytopathology. 43: 309–335.

Robbins, P. 2004. Political ecology: a critical introduction. Critical introductions to geography series. Malden, MA: Blackwell.

Roy, B.A.; Alexander, H.M.; Davidson, J.; Campbell, F.T.; Burdon, J.J.; Sniezko, R.; Brasier, C. 2014. Increasing forest loss worldwide from invasive pests requires new trade regulations. Frontiers in Ecology and the Environment. 12:457–465.

Simberloff, D. 2006. Risk assessments, blacklists, and white lists for introduced species: Are predictions good enough to be useful? Agricultural and Resource Economics Review. 35(1): 1–10.

Thompson, R.N.; Cobb, R.C.; Gilligan, C.A.; Cunniffe, N.J. 2016. Management of invading pathogens should be informed by epidemiology rather than administrative boundaries. Ecological Modeling. 324: 28–32.

Weber, G.A. 1930. The Plant Quarantine and Control Administration: its history, activities and organization. Washington, DC: The Brookings Institution.

Weste, G. 2003. The dieback cycle in Victorian forests: a 30-year study of changes caused by *Phytophthora cinnamomi* in Victorian open forests, woodlands and heathlands. Australasian Plant Pathology. 32: 247–256.

Weste, G.; Marks, G.C. 1987. The biology of *Phytophthora cinnamomi* in Australian forests. Annual Review of Phytopathology. 25: 207–229.

World Trade Organization. 1994. World Trade Organization agreement on the application of sanitary and phytosanitary measures. https://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm. (03 January 2017).

Zobel, D.B.; Roth, L.F.; Hawk, G.M. 1985. Ecology, pathology, and management of Port-Orford-cedar (*Chamaecyparis lawsoniana*). Gen. Tech. Report PNW-184. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 161 p.