ISAC

INVASIVE SPECIES ADVISORY COMMITTEE

C/O NATIONAL INVASIVE SPECIES COUNCIL
U.S. DEPARTMENT OF THE INTERIOR · OFFICE OF THE SECRETARY
1849 C STREET NW · WASHINGTON, DC 20240

Underserved Communities and Invasive Species

ADOPTED NOVEMBER 14, 2023

Introduction

FINDINGS

❖ Invasive species impact underserved communities, sometimes disproportionately, and there are both individual and compounded or synergistic impacts with climate change.

❖ Many underserved communities are not mappable, some are not reflected or identified in the Climate and Economic Justice Screening Tool (CEJST)

❖ The CEJST was not built to include invasive species, their impacts, or how they may intersect with or be exacerbated by climate change. The vast majority of datasets do not include any aspect of invasive species.

❖ There are too many invasive species to map, some defy the type and scope of mapping relevant to the CEJST, and there is no national initiative to collect longitudinal data on invasive species, but there are opportunities.

❖ Invasive species do not respect jurisdictions or census tracts; sometimes it is best to invest where it is most effective, including investing outside of mapped underserved communities to protect those communities from harm. Therefore, CEJST should not necessarily determine how to provide support concerning invasive species projects.

Several Executive Orders (E.O.) including E.O. 13985, *Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*, E.O. 14008, *Tackling the Climate Crisis at Home and Abroad*, and E.O. 14096, *Revitalizing Our Nation's Commitment to Environmental Justice for All*, along with spending language in the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA), direct federal agencies to focus on environmental justice, underserved communities, and climate change. The Justice 40 initiative that arose from E.O. 14096 expressly set a goal for 40% of overall benefits from certain Federal investments to benefit underserved communities in seven areas related to climate and infrastructure, though not expressly including invasive species.

This paper seeks to 1) summarize some ways that invasive species impact underserved communities, sometimes disproportionately, and how a changing climate exacerbates those impacts; 2) illustrate ways in which some underserved communities being impacted by invasive species may or may not be identified through the new data mapping tools; 3) highlight how the almost complete absence of national invasive species datasets and guidance on the interplay between climate change and invasive species can result in an incomplete picture of harm and needs; and 4) provide best practices and recommendations that can help guide agencies in meeting the directives and the needs of underserved communities regarding invasive species.

Issue

Invasive species can have negative economic, agricultural, ecological, public health, social, and cultural impacts. Most of the documented examples focus primarily on economic, agricultural, ecological, and public health impacts and costs. However, the impacts of invasive species on community wellness, cultural and indigenous practices, and social traditions are notoriously difficult to quantify and/or document (Small et al. 2017, Pascual et al. 2023). In addition, there are clear, synergistic effects between invasive species and climate change that are already occurring and that will likely be compounded in the coming years, with implications that should be considered and addressed in tandem (Mainka and Howard 2010, Hulme 2017, Weiskopf et al. 2020, Mora et al. 2022). In most cases, the negative effects of these two change-drivers will likely be magnified for underserved communities, even if infestations occur outside of the mapped boundaries of those communities.

E.O. 13985 calls on agencies to identify how they will equitably support underserved communities through their mandates, and federal agencies have responded by identifying and describing the underserved communities they serve, leading to a variety of similar terms and confusing descriptions of programs to serve these groups. For the purpose of this paper, we utilize the definitions in E.O. 13985 which describes the term "equity" as:

> ...the consistent and systematic treatment of all individuals in a fair, just, and impartial manner, including individuals who belong to communities that often have been denied such treatment, such as Black, Latino, Indigenous and Native American, Asian American, Native Hawaiian, and Pacific Islander persons and other persons of color; members of religious minorities; women and girls; LGBTQI+ persons; persons with disabilities; persons who live in rural areas; persons who live in United States Territories; persons otherwise adversely affected by persistent poverty or inequality; and individuals who belong to multiple such communities. (E.O. 13985)

The term "underserved communities" refers to:

> ...those populations as well as geographic communities that have been systematically denied the opportunity to participate fully in aspects of economic, social, and civic life, as defined in Executive Orders 13985 and 14020. (E.O. 13985)

Identifying underserved communities as described in E.O. 13985 can be difficult in and of itself. In January 2021, E.O. 14008 directed the White House Council on Environmental Quality

(CEQ) to develop a new tool to help Federal agencies identify those underserved communities that can be mapped in order to prioritize and document support to these communities. The Climate and Economic Justice Screening Tool (CEJST) is a publicly available website with a map interface that uses a variety of national datasets, including census data, to identify geographic communities experiencing burdens in any of eight categories including climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development. The tool uses this information to identify communities that are experiencing these burdens and thus are overburdened and underserved.

However, of the 34 datasets currently being used, only two minor aspects of these data measure or document any aspect of invasive species. The first is data collected by the Federal Emergency Management Agency (FEMA) for the National Risk Index Tool which includes the projected agricultural loss rate in dollars, but it does not include projections for agricultural loss due to invasive species, nor does it include data for the territories or Freely Associated States. The second is a private foundation climate dataset, yet only the projected wildfire risk dataset includes an aspect of invasive species (wildfire risk, which can sometimes be influenced by pest damage to trees, fire-promoting invasive grasses, etc.), but the data does not include Hawaii, Alaska, the territories, or Freely Associated States. The CEJST does not reflect the growing importance and expansion of "non-native" human disease pathogens and vectors. Further, the CEJST also does not include insect and disease information from the USDA Forest Service Forest Health and Protection program which includes information for some forest pests in the continental United States and the Hawaiian Islands and national insect and disease risk mapping.

Case Studies

The following case studies provide examples of how invasive species affect different underserved communities, where existing map-based data tools may help guide Federal support programs, and where they are inadequate or not appropriate.

~

THE LOSS OF TREES DUE TO INVASIVE PESTS AND IMPACTS ON UNDERSERVED COMMUNITIES

Examples of how some invasive species affect underserved communities can be seen with the emerald ash borer, Asian longhorned beetle, invasive shot hole borers, and other invasive tree pests that damage and kill trees in natural and urban areas. Invasive shothole borers have infested and killed thousands of trees in urban landscapes and adjacent natural areas throughout southern California and have the potential to cause more damage if left unchecked. The emerald ash borer has killed tens of millions of trees in the United States since

its introduction in 2002, and these beetles continue to spread through neighborhoods and forests (USDA APHIS 2023). There is a projected loss of 30% of urban forests and incalculable losses to natural areas if the Asian longhorned beetle continues to spread (Nowak et al. 2001). A loss of urban trees can result in the loss of community-wide environmental benefits such as local cooling and sun protection, increased energy needs, carbon sequestration, air pollution removal, and decreased soil erosion and run-off during extreme weather events (Akbari et al. 2001, Nowak et al. 2013, Berland et al. 2017). Loss of urban trees has also been linked to lower property values, an increase in crime, and higher stress in urban settings (Conniff 2020, Wolf 2020).

The loss of trees and canopy particularly affects historically marginalized communities that disproportionately live in urban environments where green spaces are already limited (Nowak et al. 2022). The inclusion or use of satellite imagery datasets from the National Land Cover Database currently uses only "green space" to look at wildfire risk and does not use other land cover data. Including tree canopy cover data could potentially allow agencies to focus on communities with a loss or lack of tree canopy, due to invasive tree pests or other reasons, and it could also help with climate resilience measures. However, it is important to note that the pre-invasion conditions of landscapes in underserved communities may reflect a deficit in "green space" due to historical conditions such as redlined neighborhoods or systematic negligence of tree canopy maintenance. Urban forestry goals should focus on eliminating historic inequities while mitigating invasive species impacts and improving canopy resilience. In addition, the lack of regularly updated and standardized wildland and urban national datasets on invasive tree pests and their impacts can be addressed by working in communities or with states, counties, and non-governmental organization liaisons to better identify those affected underserved communities.

IMPACTS OF HUMAN HEALTH PATHOGENS AND THEIR VECTORS ON UNDERSERVED COMMUNITIES

Pathogens such as West Nile virus (WNV) have impacts on human health that can be amplified within minority and low-income communities (Kollars 2017). WNV is an introduced pathogen that was first detected on the East Coast of the United States in 1999 and within a three-year period it had extended its range to the West Coast. The disease spreads when mosquito vectors bite infected birds, and then bite uninfected birds or other animals. In addition to its lethal and sub-lethal effects on birds and horses, WNV can cause flu-like symptoms and severe illnesses such as encephalitis, meningitis, and even death in 1 in 150 infected people (Centers for Disease Control 2023). Since its introduction into the United States, researchers have worked on predictive mapping for human risk. In Orange County, California, prevalence of the WNV parasite in both vectors and humans was best explained by economic variables, specifically low income, high population density, and other factors associated with urban underserved communities (Harrigan et al. 2010). When comparing human cases of WNV in the counties of Alabama from 2007-2017, researchers found a significant convergence between the incidence of the disease and poverty rate clustered in the southern part of the state (Bisanzio et al. 2021). Additionally, researchers in Chatham County, Georgia found that those living in minority and indigent communities were 4.5 and 5.5 times more likely to be at risk of WNV than predominately white and wealthy communities (Kollars 2017). The economic impact of the virus on individual households can be significant with medical costs varying from \$7,500 to \$25,000 and an overall cumulative cost to the United States of \$778 million in healthcare expenditures and lost productivity over the period of 1999 to

2014 (Staples et al. 2014). Climate change has and will continue to increase the spread and impacts of human and wildlife pathogenic diseases, in large part due to the spread of vectors like mosquitoes (Mora et al. 2022). The CEJST would likely be able to identify many underserved communities at higher risk of invasive pathogens and their vectors, but as noted previously, the health datasets do not include or capture the existing or rising risk of human health diseases associated with the interactions between invasive species and a changing climate.

INVASIVE PEST IMPACTS TO FOOD, CULTURE, AND WAY OF LIFE AND EFFECTS ON UNDERSERVED COMMUNITIES

A third case study can be seen with the invasion of coconut rhinoceros beetles which are native to Southeast Asia but have invaded several U.S. Pacific Islands (PESC 2022). The coconut tree is the "tree of life" to many Pacific Island communities. Islanders derive food, shelter, tools, and medicine from every part of the plant. In addition to its role as an island cultural icon, the coconut tree is of economic importance providing aesthetic value in the tourism industry and material for local craftsmen. Coconut palms also function as natural infrastructure, by buffering storms and holding shorelines and soil (Chan and Elevitch 2006). The beetles damage and kill coconut palms, resulting in the loss of traditional cultural knowledge and practices (PESC 2022). There is no holistic way to quantify the value of these cultural losses or the magnitude of the impacts from invasive species with such wide-ranging effects.

Like other Pacific islands, coconut palms in Hawaii are ubiquitous across the islands. So too are the many Native Hawaiians and Pacific Islanders who rely on coconut, only some of whom live in geographic locations classified as underserved by the CEJST. On one hand, the CEJST can identify and map census tracts where the density of a community (e.g., people on welfare or people living near a superfund site) meets the threshold required to be considered "underserved", but it cannot be used to identify communities (persons) that may not live in densities that meet the threshold for mapping. In this context, Native Hawaiians and Pacific Islanders do not belong to Federally recognized tribes and do not necessarily live in certain areas that are mapped as underserved. The CEJST continues to improve as new datasets are added. One missing component is that the CEJST website does not clearly refer to or include a statement reflecting the full description of E.O. 13985 communities, including Native Hawaiians and U.S.-affiliated Pacific Islanders, thus it may not be clear that these communities should be considered underserved. For these people, there are incalculable costs and impacts on their culture, health, and wellbeing, including the generational loss of a way of life (Brewington et. al 2023), which are impacts that can't be seen in datasets. Federal agencies must engage directly with communities in addition to consulting metadata and continue to strive for policies and programs to better address non-economic loss and damage from invasive species and climate change.

∽

**WIDESPREAD INVASIVE WEEDS AND IMPACTS
ON UNDERSERVED COMMUNITIES**

Like all federal agencies, the U.S. Department of Agriculture has been charged with developing and implementing comprehensive equity strategies which include identifying underserved communities. One of these communities is comprised of the more than 65,000 underserved producers in Oklahoma, according to the 2017 National Agriculture Statistical Survey. One of the more aggressive invasive weeds impacting agricultural production is the musk thistle which was introduced to the United States over 150 years ago and has since spread to more than 40 states. Musk thistle impacts grazing lands in a short amount of time because of its prolific seed production and wind-dispersal, and its spiny stems and leaves which significantly reduce the productivity of grazable land and resulting economic impact (Zouhar 2002). There is federal funding specific to noxious weeds for Tribes in Oklahoma, however, this process is nationally competitive, resulting in very limited funding awards. Funding to date has resulted in a patchwork of control efforts, rapid re-invasion from neighboring properties not under control, an inability to plan from year to year, and inefficient use of resources in the short and long term on a landscape scale. There is a significant education deficit on the impacts of invasive weeds, the direct impacts on agricultural production, and a lack of awareness of how to effectively manage them. Regional and local education such as extension programs and conservation districts can assist underserved communities in developing effective landscape-scale invasive species control projects and navigating grant processes.

While underserved communities may be disproportionally affected by the impacts or costs of invasive species such as musk thistle, Federal agencies should follow sound invasive species control strategies and apply programs and funding in a sustained and effective way across an invaded landscape to benefit all, including underserved communities.

Invasive Species Datasets

Unlike national datasets on income, poverty, or availability of broadband that come from longitudinal studies for the purpose of characterizing and comparing community-level data across the nation, there is no national dataset for invasive species, and no census-like national effort to collect and maintain invasive species data. While local, regional, and federal datasets on some species exist, the data are collected to meet different objectives and often come with specific caveats. Some, like musk thistle, are too widespread to accurately map, while others like WNV, emerge and recede annually with their vectors, and the seasonal data may or may not be collected by counties or states. The invasive shothole borer currently occupies a relatively small area, although that doesn't accurately convey the need for early detection in surrounding areas. And then there are aquatic species such as invasive carp, marine species like the European green crab, and cryptic species in complex environments (e.g., Burmese pythons) that are difficult to accurately survey and map. With countless non-native pathogens, fungi, plants, and animals, many thousands of which are or will become invasive, there are too many invasive species to map or maintain accurate data as they spread and new ones arrive.

It is important to note that national datasets can play a significant role in defining the regional or national scope of some types of established invasive species but may be less helpful in other circumstances. The best and most cost-effective strategies for addressing an invasive species are determined by a variety of factors, such as the extent of the infestation, available control options, ability to contain spread, funding, and even political will. The application of invasive species prevention and control strategies, and even restoration post-invasion, must occur at the most biologically effective points and should not be overly driven by proximity to underserved communities. Sometimes the most cost-effective way to support underserved communities is to take action on invasive species before they reach those communities.

It is important to note that large invasive species datasets do exist, but do not provide the types and coverage of data needed for use in the CEJST. It is also important to note that many of the underserved communities have limited invasive species data due to the lack of resources and, in some cases, the human population and capacity required to survey and map invasive species.

Recommendations

Existing data cannot identify how to meet the needs of underserved communities with respect to the many and varied invasive species and their impacts. The examples in this paper illustrate that each community should be met where they are so that federal agencies may best understand local priorities, needs, and barriers, and work with communities to find culturally informed, mutually acceptable ways to address them. One example of an agency meeting underserved communities where they are is the Department of the Interior's (DOI) direct engagement with territories and relevant federal agency representatives to plan and gather at the Territorial Climate and Infrastructure meetings in 2022 and 2023. Planning calls were held to meet the needs of Pacific territories' time zones, resulting in multiple late evening meeting times for Federal agency leaders. After listening to purchasing and shipping challenges in remote Pacific Island territories in 2022, DOI sought approval for a temporary waiver from the Buy America requirement of the Infrastructure Investment and Jobs Act. Other liaison work can be seen with the regional outreach efforts like USDA Forest Service's State, Private, and Tribal Forestry program, the U.S. Geological Survey Climate Adaptation Science Centers, and the National Oceanic and Atmospheric Administration Climate Adaptation Partnerships and Sea Grant Programs as examples. Federal agencies are applauded for these and similar efforts and urged to further explore and implement ways to engage with and support underserved communities directly and meaningfully.

The following areas are highlighted as particular needs common to many underserved communities.

NEED: INCREASE UNDERSERVED COMMUNITIES ACCESS TO FEDERAL GRANT OPPORTUNITIES

Successful invasive species programs are often determined by the availability of grants and the local capacity to organize, plan, apply for, as well as fiscally administer, manage, and implement a grant and project or program. Grant funding tends to be awarded to those communities that have a good track record with federal grants, that employ professional grant writers, or that have local capacity to write and administer federal grants according to federal guidelines. In the case of cost-reimbursable grants and agreements, the receiving organization must have access to sufficient financial resources (e.g., credit, capital reserves) to front costs while awaiting federal grant reimbursement. This can lead to excluding or perpetuating the exclusion of other communities that lack these capacities. Improving the capacity of underserved communities with grant processes could address this area.

The value of technical assistance and outreach can be seen in the Native American Fish and Wildlife Society's (NAFWS) work. In 2022, NAFWS identified a need within Tribal governmental/natural resource programs to provide technical assistance for the "America the Beautiful Challenge" (ABC) grant. The need arose out of the complexity of the grant portal and application process and the quick turnaround necessary for drafting and submitting a fundable proposal. The NAFWS provided a seven-part ABC webinar/workshop series that served over 100 participants and 62 Tribes. This outreach resulted in Tribes submitting 31% of the total ATBC funding proposals, and of the 14 Tribes that were awarded funding, 11 had attended and participated in the NAFWS webinar series.

A successful program that meets underserved agricultural producer community needs is USDA's grant opportunities administered through the Natural Resources Conservation Service (NRCS) with programs such as the Environmental Quality Incentives Program, Conservation Stewardship Program, and Regional Conservation Partnership Program which provide assistance to underserved farmers, ranchers, urban agriculture, and tribal lands. These programs rely on localized communication and assistance from the local NRCS offices and staff. Continuing to improve these connections and expanding outreach about other government, corporate, and private grants can help. Without the knowledge that they even exist, these grants cannot serve their purpose.

GRANT RECOMMENDATIONS

ISAC recommends that NISC member agencies work with underserved communities to understand their financial barriers and incorporate flexibility within the grant processes to overcome those barriers, by implementing the following recommendations:

❖ Support outreach to, and possibly embedded within, underserved communities to bring their attention to invasive species issues and opportunities, and to listen to the needs and priorities of the community. Local liaisons are key.

❖ Improve and support local capacity for the fiscal administration of federal grants for invasive species-related projects through the local cooperating Federal agencies, or through non-federal local partners.

❖ Simplify and clarify application processes and any online submittal portals.

❖ Provide materials in the preferred languages of the underserved communities.

❖ Always provide an alternate submittal option such as secure email for those areas with low bandwidth.

❖ Stagger the timing of due dates for different grant applications and deliverables.

❖ Clarify eligibility requirements including the underserved communities that are being prioritized.

❖ Agencies should consider waiving match requirements or allowing in-kind or "earnest effort" documentation in lieu of match requirements wherever possible.

❖ Ensure writing assistance is available by providing funding for grant writers or personnel to provide technical writing assistance.

∽

NEED: INCREASE AND INTEGRATE DATA AND CLARIFY COMMUNICATIONS

Although currently prioritized as underserved communities, Native Hawaiians, Pacific Islanders, and some others are not Federally recognized tribes, which has compounding parity implications. Further, the main webpages of the CEJST do not include language regarding these communities which can cause confusion. Agencies should consider how and if equity goals can be met when prioritizing some but not all indigenous tribes and peoples.

The CEJST is ambitious and additional datasets continue to improve its utility in many ways. Additional updates to available datasets can help; for example, the Centers for Disease Control should update the data that feeds into the National Risk Index tool so that it incorporates national health and nutrition data, as well as invasive species-vectored human diseases. FEMA should consider how it might gather and incorporate the projected loss rate related to invasive species as a natural hazard and a category of risk that is as costly as natural disasters, and which results in ongoing loss, costs, and compounding damage (Turbelin et al. 2023). There are also national climate projections for almost every region, and CEQ is encouraged to integrate this data within their tool, which may enable the projection of climate-facilitated range shifts of invasive species with human health connections. The satellite imagery datasets from the National Land Cover Database and any available coral reef datasets should also be explored for additional utility, including prioritizing the protection and enhancement of natural infrastructure.

There are significant climate change and invasive species synergies. Planning projects to address either of these issues is difficult, but planning projects to best address a compounding or synergistic issue is well beyond what many underserved communities are able to address. Further, most funding opportunities do not encourage or facilitate proposals and projects that work to address both invasive species and climate issues or resilience work.

1. Consider multi-disciplinary, interagency efforts to synthesize and provide informational materials and communications, including through funding opportunities, that articulate the interactions and synergies between invasive species and climate change, and that provide invasive species management assistance to underserved communities to successfully advocate for local needs while also meeting climate and infrastructure goals.

2. Agencies should continue and accelerate support for research and actions that prevent the introduction and establishment of new invasive species that could impact underserved communities at local, regional, and national levels, including additional research, horizon scanning, and risk assessments in light of geopolitical and economic shifts associated in part with a changing climate. Regional Invasive Species and Climate Change Management Networks (RISCCs) are in various stages of formation across North America and the U.S. Pacific Islands and serve to identify and meet the needs of each region. These concepts, and more, are also explored in depth in the 2023 ISAC white paper on climate change entitled "Invasive Species Threaten the Success of Climate Change Adaptation Efforts."

Acknowledgements

References

Akbari, H., M. Pomerantz, H. Taha. (2001). Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas, Solar Energy, Volume 70, Issue 3, Pages 295-310, ISSN 0038-092X, https://doi.org/10.1016/S0038-092X(00)00089-X

Berland A., S. Shiflett, W. Shuster, A. Garmestani, H. Goddard, D. Herrmann, M. Hopton. (2017) The role of trees in urban stormwater management. Landscape Urban Planning 162: 167-177. https://doi.org/10.1016/j.landurbplan.2017.02.017

Bisanzio D, E. Martello, K. Izenour, K. Stevens, R. Kaur, B. McKenzie, M. Kraemer, E. Reithinger, S. Zohdy. (2021) Arboviral diseases and poverty in Alabama, 2007–2017. PLoS Neglected Tropical Diseases 15(7): e0009535. https://doi.org/10.1371/journal.pntd.0009535

Brewington, L., B. Eichelberger, N. Read, E. Parsons, H. Kerkering, C. Martin, W. Miles, J. Idechong, J. Burgett. (2023). Pacific Island Perspectives on Invasive Species and Climate Change. In: Walsh, S.J., Mena, C.F., Stewart, J.R., Muñoz Pérez, J.P. (eds) Island Ecosystems. Social and Ecological Interactions in the Galapagos Islands. Springer, Cham. https://doi.org/10.1007/978-3-031-28089-4_5

Centers for Disease Control and Prevention. (2023, October 13) West Nile Virus Symptoms, Diagnosis & Treatment. https://www.cdc.gov/westnile/symptoms/index.html

Chan, E., and C. Elevitch. (2006). Cocos nucifera (coconut), ver 2.1. In: Elevitch, C.R. (ed.). Species profiles for Pacific Island agroforestry. Permanent agriculture resources (PAR), Holualoa, HI. Accessed via: https://www.agroforestry.net/images/pdfs/Cocos-coconut.pdf

Conniff, R. (2020, July 20). Trees shed bad rap as accessories to crime. Environment Yale. Yale School of Forestry & Environmental Studies. https://resources.environment.yale.edu/envy/stories/trees-shed-bad-wrap-as-accessories-to-crime#gsc.tab=0

Executive Office of the President. (2021). Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (Jan. 20, 2021), 86 Federal Register 7009. https://www.federalregister.gov/documents/2021/01/25/2021-01753/advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government

Executive Office of the President (2021). Executive Order 14096: Tackling the Climate Crisis at Home and Abroad (Jan. 27, 2021), 86 Federal Register 7619. https://www.federalregister.gov/d/2021-02177

Executive Office of the President (2021). Executive Order 14008: Revitalizing Our Nation's Commitment to Environmental Justice for All (Apr. 21, 2023), 88 Federal Register 25251. https://www.federalregister.gov/documents/2023/04/26/2023-08955/revitalizing-our-nations-commitment-to-environmental-justice-for-all

Harrigan, R., H. Thomassen, W. Buermann, R. Cummings, M. Kahn, T. Smith. (2010) Economic Conditions Predict Prevalence of West Nile Virus. PLoS ONE 5(11): e15437. https://doi.org/10.1371/journal.pone.0015437

Hulme, P. (2017). Climate change and biological invasions: Evidence, expectations, and response options. Biological Reviews 92(3):1297-1313. https://doi.org/10.1111/brv.12282.

Kollars, T. (2017). Identifying high risk areas of West Nile Virus in minority and low-income neighborhoods. Clinical Microbiology and Infectious Diseases. 2. https://doi.org/10.15761/CMID.1000123

Mainka, S. and G. Howard. (2010), Climate change and invasive species: double jeopardy. Integrative Zoology, 5: 102-111. https://doi.org/10.1111/j.1749-4877.2010.00193.x

Mora, C., T. McKenzie, I. Gaw, J. Dean, H. von Hammerstein, T. Knudson, R. Setter, C. Smith. K. Webster, J. Patz, and E. Franklin. (2022) Over half of known human pathogenic diseases can be aggravated by climate change. Nature Climate Change 12: 869-875. https://doi.org/10.1038/s41558-022-01426-1

Nowak, D., J. Pasek, R. Sequeira, D. Crane, V. Mastro. (2001). Potential effect of Anoplophora glabripennis (Coleoptera: Cerambycidae) on urban trees in the United States. Journal of Economic Entomology. 94(1): 116-122. https://doi.org/10.1603/0022-0493-94.1.116

Nowak, D., E. Greenfield, R. Hoehn, E. Lapoint. (2013). Carbon storage and sequestration by trees in urban and community areas of the United States. Environmental Pollution. 178: 229-236. https://doi.org/10.1016/j.envpol.2013.03.019

Nowak, D., A. Ellis, E. Greenfield. (2022). The disparity in tree cover and ecosystem service values among redlining classes in the United States. Landscape and Urban Planning. 221(3): 104370. 6 p. https://doi.org/10.1016/j.landurbplan.2022.104370

PESC – Pacific Ecological Security Conference. (2022). Strategic action plan for coconut rhinoceros beetle: management and containment across Pacific Island countries and territories. Pacific Ecological Security Conference (PESC), Koror, Palau. Zenodo. https://doi.org/10.5281/zenodo.7683205

Pascual, U., P. Balvanera, C. Anderson, R. Chaplin-Kramer, M. Christie, D. Gonzalez-Jimenez, A. Martin, C. Raymond, M. Termansen, A. Vatn, S. Athayde, B. Baptiste, D. Barton, S. Jacobs, E. Kelemen, R. Kumar, E. Lazos, T. Hwampamba, B. Nakangu, P. O'Farrell, S. Subramanian, M. van Noordwijk, S. Ahn, S. Amaruzaman, et al. (2023). Diverse values of nature for sustainability. *Nature* 620:813–823 (2023). https://doi.org/10.1038/s41586-023-06406-9

Small, N., M. Munday, I. Durance. (2017). The challenge of valuing ecosystem services that have no material benefits. Global Environmental Change, Volume 44, 2017, Pages 57-67, ISSN 0959-3780, https://doi.org/10.1016/j.gloenvcha.2017.03.005

Staples, J., M. Shankar, J. Sejvar, M. Meltzer, M. Fischer. (2014). Initial and Long-Term Costs of Patients Hospitalized with West Nile Virus Disease. American Journal of Tropical Medicine and Hygiene. 90(3): 402-409. https://doi.org/10.4269/ajtmh.13-0206

Turbelin, A., R. Cuthbert, F. Essl, P. Haubrock, A. Ricciardi, F. Courchamp. (2023). Biological invasions are as costly as natural hazards. Perspectives in Ecology and Conservation 21(2): 143-150. https://doi.org/10.1016/j.pecon.2023.03.002

USDA APHIS. (2023, 13 October). Plant Health, Pests and Diseases: Emerald Ash Borer https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/emerald-ash-borer

Weiskopf, S., M. Rubenstein, L. Crozier, S. Gaichas, R. Griffis, J. Halofsky, K. Hyde, T. Morelli, J. Morisette, R. Munoz, A. Pershing, D. Peterson, R. Poudel, M. Staudinger, A. Sutton-Grier, L. Thompson, J. Vosa, J. Weltzin, K. Powys Whyte. (2020). Climate change effects on biodiversity, ecosystems, ecosystem services, and natural resource management in the United States. Sci. Total Environ. 733:137782. https://doi.org/10.1016/j.scitotenv.2020.137782

Wolf K., S. Lam, J. McKeen, G. Richardson, M. van den Bosch, A. Bardekjian. (2020). Urban Trees and Human Health: A Scoping Review. Int J Environ Res Public Health. 17(12):4371. https://doi.org/10.3390/ijerph17124371.

Zouhar, K. 2002. Carduus nutans. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.usda.gov/database/feis/plants/forb/carnut/all.html [2023, August 1].