Entomological Society of America
Sharing Insect Science Globally

ESA Position Statement on Climate Change

Approved on January 25, 2019
Valid through January 25, 2023

Global climate change is one of the greatest challenges facing ecosystems and societies. Climate change is a broad term that encompasses several variables, including changes in rainfall and daily temperature patterns, and increased frequency and intensity of extreme weather events (e.g., heat waves, floods, droughts). These environmental changes are profoundly disruptive to both natural and managed ecosystems, with implications for a broad scope of economic sectors relevant to people's health and food security, including agriculture, fisheries, forest management, and urban development. There are already demonstrable ecological effects of climate change. Action is needed to respond to current problems as well as mitigate future impacts.

Given their centrality in most habitats on the planet, responses of insect species to climate change will inevitably have broad-reaching environmental consequences (likely possibilities are summarized in Fig. 1).

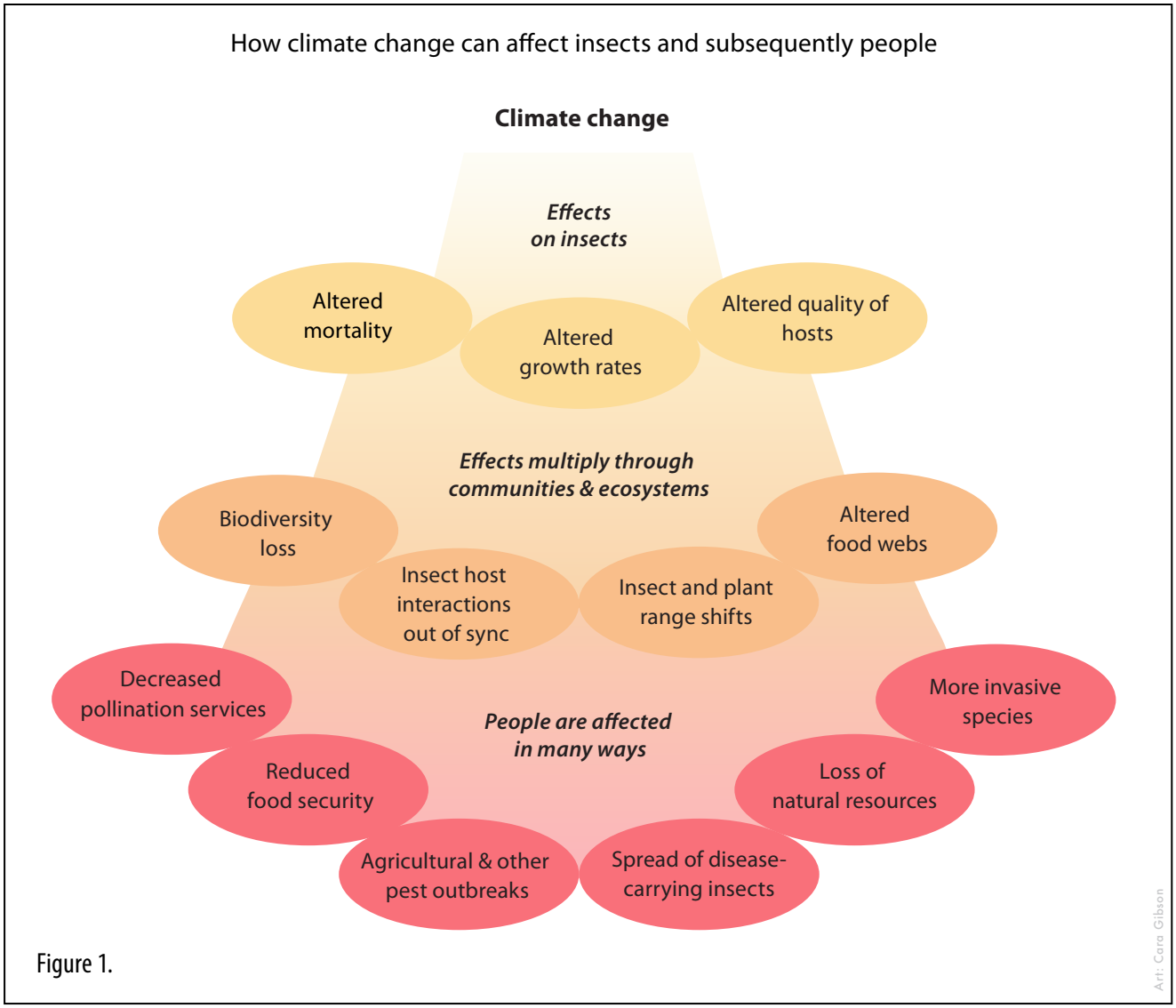

Figure 1.

Nearly three quarters of known species are insects or their allies (e.g., ticks and other invertebrates), and these extremely diverse organisms are critical to healthy ecosystems. Insects are both key indicators and important architects of climate change impacts. Climate change is already negatively affecting insects that provide ecological and societal benefits, including pollinators, natural enemies of pests, and insects that decompose dead plants and animals. Simultaneously, climate change is altering the distribution and prevalence of harmful insects, including species that transmit diseases, and invasive crop pests.

Climate change related degradation of agricultural, urban, and forested areas is also indirectly increasing the risk of insect and disease outbreaks.

Some of the specific documented effects of climate change on insects include:

- *Direct impacts of temperature*. Changes in average temperatures and increased temperature extremes affect insect abundance. In certain climate zones, temperature changes can lead to higher insect survival, altered death and growth rates, earlier emergence, and more reproductive cycles. For example, in the western United States and Canada, as well as the southern U.S., the periodic outbreaks of pine beetles that devastate vast acreages of forest have increased in severity over the last decade, due in part to milder winters that allow more generations of beetles per year to grow and reproduce, a process that increases population size (Fig. 2)[1,2].

Current knowledge is insufficient to predict the diverse effects of climate warming on insects, as these effects depend on many factors including climate zone, the biology[3] of individual species, and temperature-dependent impacts on host plants. Notably, many of these temperature effects are exacerbated by other climatic variables like changes in precipitation[4].

How climate change can increase the number of pests per year

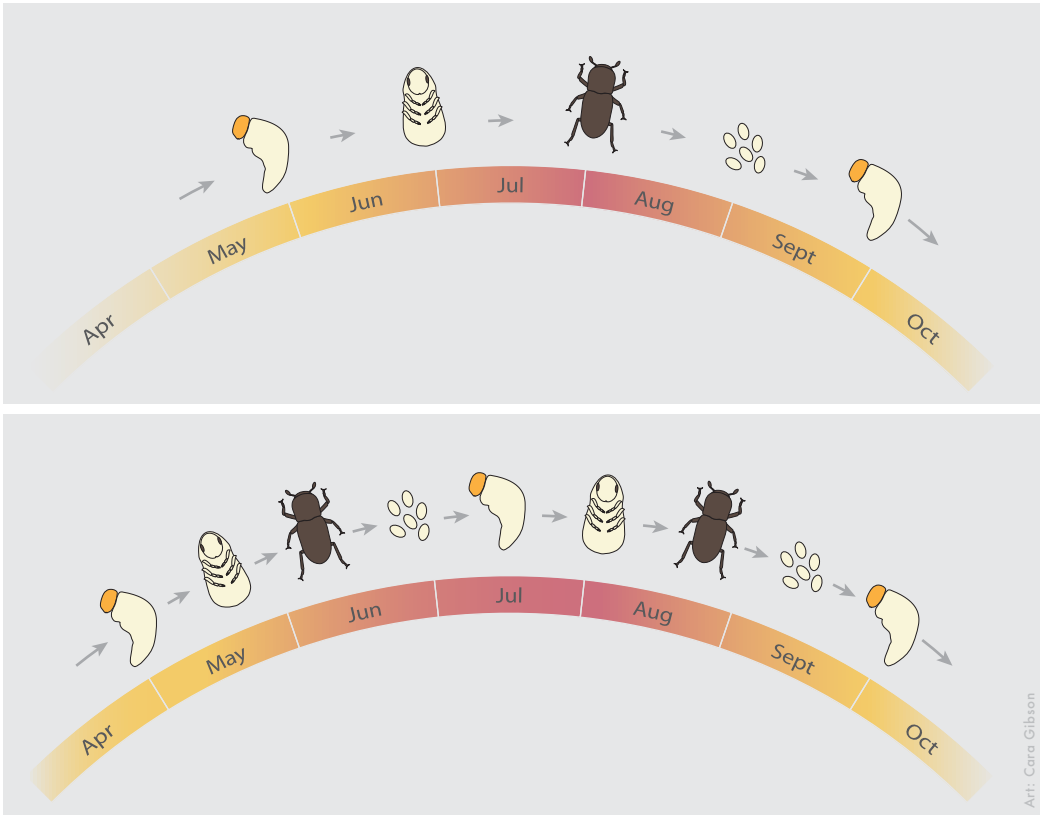

Figure 2.

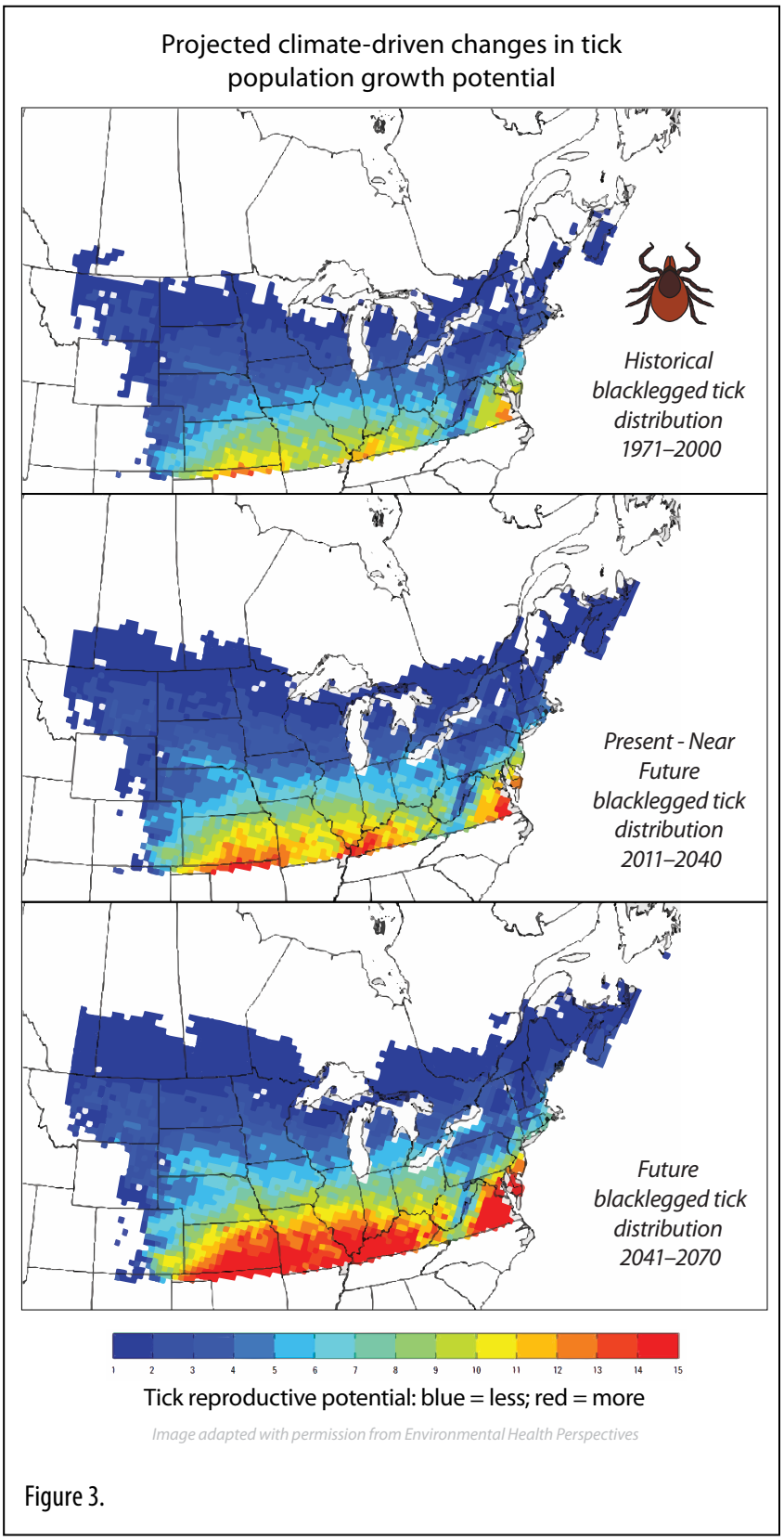

Figure 3.

- *Changes in insect distributions*. Insect ranges are shifting in response to climate change[5]. For species specialized to live in cold or alpine areas (e.g., some bumble bees), suitable habitats are disappearing, and ranges are contracting[6]. In the Northern Hemisphere, less specialized species are expanding their range northward as warming creates new suitable habitats. For example, in one study, three out of four butterfly species were documented to have undergone northward range expansions[5]. Range shifts of agricultural pests, species that transmit disease (e.g., mosquitos and ticks, Fig. 3[7]), invasive species, and pollinators are likely to have significant impacts on people.

The shifts in population ranges due to climate change vary across species. As a result, large-scale ecological surveys across the diversity of insect life are necessary to predict outcomes.

- *Biodiversity and biomass loss*. Climate change is contributing to an overall reduction in insect diversity and abundance[8,9]. Researchers in Europe found an over 75% decline in the biomass of flying insects in a 27 year period[13]. Records over 110 years across Europe and North America documented climate-driven global declines in bumble bee populations[6].

Due to their climate sensitivity and large ecological footprint, insects collectively serve as "canaries" in vast numbers of coal mines, providing advance notice of the forthcoming impacts of climate change on other organisms such as the plants that depend on them for pollination and the larger animals that depend on them for food.

- *Changes in food web interactions*. Climate change indirectly affects insect food plants, predators, parasites, and microbes. For example, the timing of seasonal life cycles of pollinating insects and the plants they depend upon can become out of sync due to fluctuations in temperature and precipitation, resulting in disrupted pollination (Fig. 4[10,11,12]). For insects that specialize on one plant, these changes can be particularly devastating, leading to local extinction; loss of specialists is often associated with dramatic changes to ecosystems. In addition to pollination, timing changes can increase injury to crops from insect feeding. Moreover, changes in temperature, precipitation, and atmospheric CO_2 are all known to alter plant quality, with consequences for plant-feeding insects as well as pollinators. Altered plant chemical defenses impact pest feeding dynamics[13], while changes to nectar and pollen can reduce the longevity of pollinating insects[6].

The broad range of indirect effects of climate change on insect ecology remain poorly understood and further research in these areas is strongly recommended.

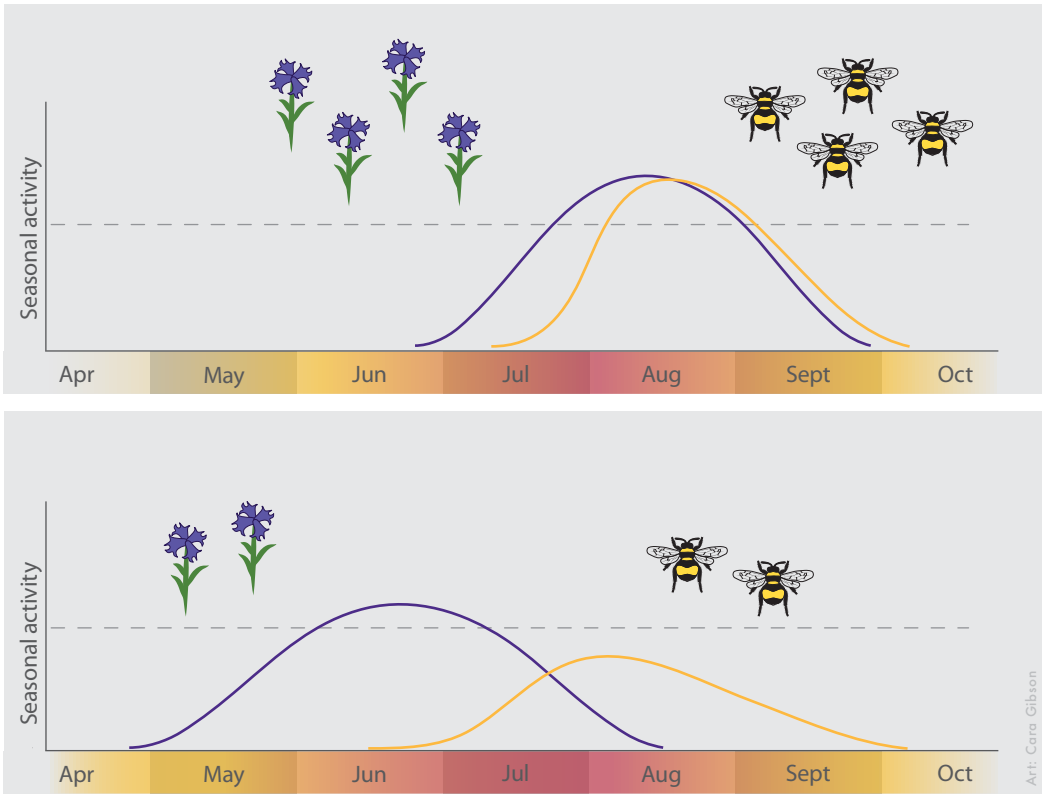

Figure 4.

The ESA advocates for policy and funding priorities to address the effects of climate change on insects and their relatives (e.g., ticks). Specific areas of emphasis include, but are not limited to:

- *Research funding that targets diverse species and a broader focus on ecosystem functioning*. Predicting the insect-relevant impacts of climate change requires research that targets representative species from every branch of the insect tree of life. Moreover, research is needed to explain more comprehensively how interacting communities of organisms will respond to climate change. Such research will enable better predictions of the physiological and ecological conditions that promote and constrain insect population growth, and the climate factors that contribute to these patterns. This information is critical to policy and management decisions.

- *The development of climate adaptation strategies*. Adaptation strategies are required for natural and agricultural ecosystems to continue functioning despite climate change. For insects, such strategies include Integrated Pest Management (IPM) approaches that accommodate a shifting pest landscape, changes in land-use to promote pollination services, and a public health response to increased disease prevalence in new and vulnerable areas.

- *A focus on science communication and incentives for cooperation among stakeholders*. Implementing climate adaptation strategies requires communication among scientists, land managers, and growers, as well as incentives for cooperation. Key to these efforts is improved public outreach to convey the impacts of climate change and to promote the best practices for adapting to a new climate regime. Developing and maintaining international collaborations and partnerships among scientists and other stakeholders is also central to addressing climate change as a global phenomenon.

The climate is rapidly changing in a way that will continue to impact insect populations. There is an urgent need for science-informed actions, policy decisions, and strong funding initiatives that address the effects of climate change on both pest and beneficial insects. The ESA urges federal lawmakers to support legislative priorities that improve our understanding of the scope of climate impacts, and aid in the development of workable solutions.

ESA is the largest organization in the world serving the professional and scientific needs of entomologists and people in related disciplines. ESA today has over 7,000 members affiliated with educational institutions, health agencies, private industry, and government. Headquartered in Annapolis, Maryland, the Society stands ready as a non-partisan scientific and educational resource for all insect-related topics. For more information, visit www.entsoc.org.

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