Darwin Day 2022 Lecture
Heroes of Evolution—E.O. Wilson

Stephen L. Gasior Ph.D.
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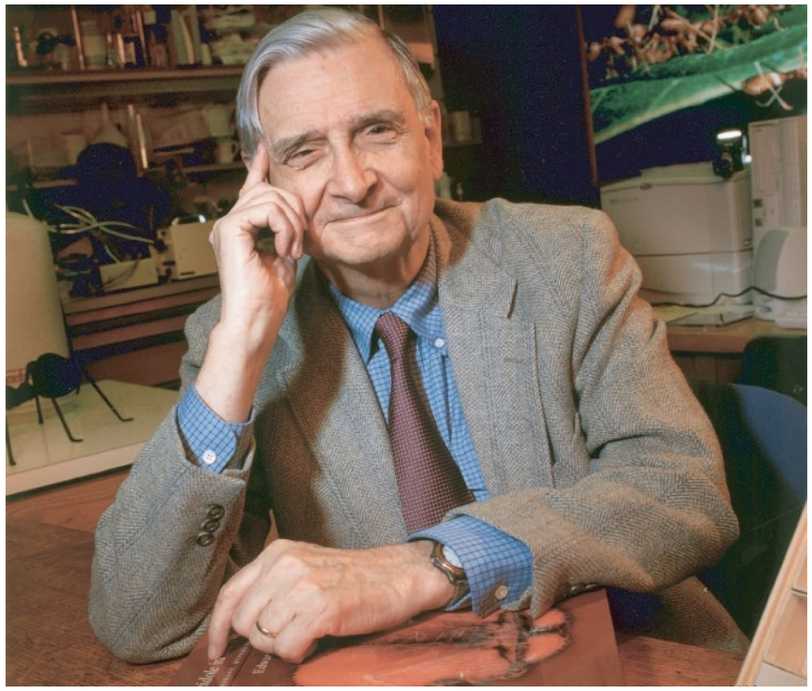
February 12th, 2022
Science Circle

Wilson



In his office in 2003

credit: Jim Harrison - PLoS

- Born June 10, 1929 in Birmingham, Alabama, a single child and lived in multiple small rural towns
- An outdoors explorer and naturalist at a young age
- enrolled in the University of Alabama after all, B.S. and M.S. degrees in biology there in 1950.
- Went to Harvard University in 1951 and appointed to the Harvard Society of Fellows, Ph.D. 1955
- Faculty at Harvard 1956 - 1996, retired but still Professor Emeritus and Honorary Curator in Entomology until 2002
- In 1973, Wilson was appointed the curator of entomology at the Harvard Museum of Comparative Zoology
- Major published works: *The Theory of Island Biogeography*, 1967; *Sociobiology: The New Synthesis*, 1975; *On Human Nature*, 1978; *The Ants*, 1990; *Consilience*, 1998; *E.O. Wilson's Life on Earth*, 2014, iPad Textbook
- Founded the E.O. Wilson Biodiversity Foundation
- coined the phrase *scientific humanism* as "the only worldview compatible with science's growing knowledge of the real world and the laws of nature". Was one of the signers of the *Humanist Manifesto* in 2003
- died December 26, 2021

Wilson: The Ant Man

Early fishing accident left him blind in one eye. But, promoted his focus on the small and close up

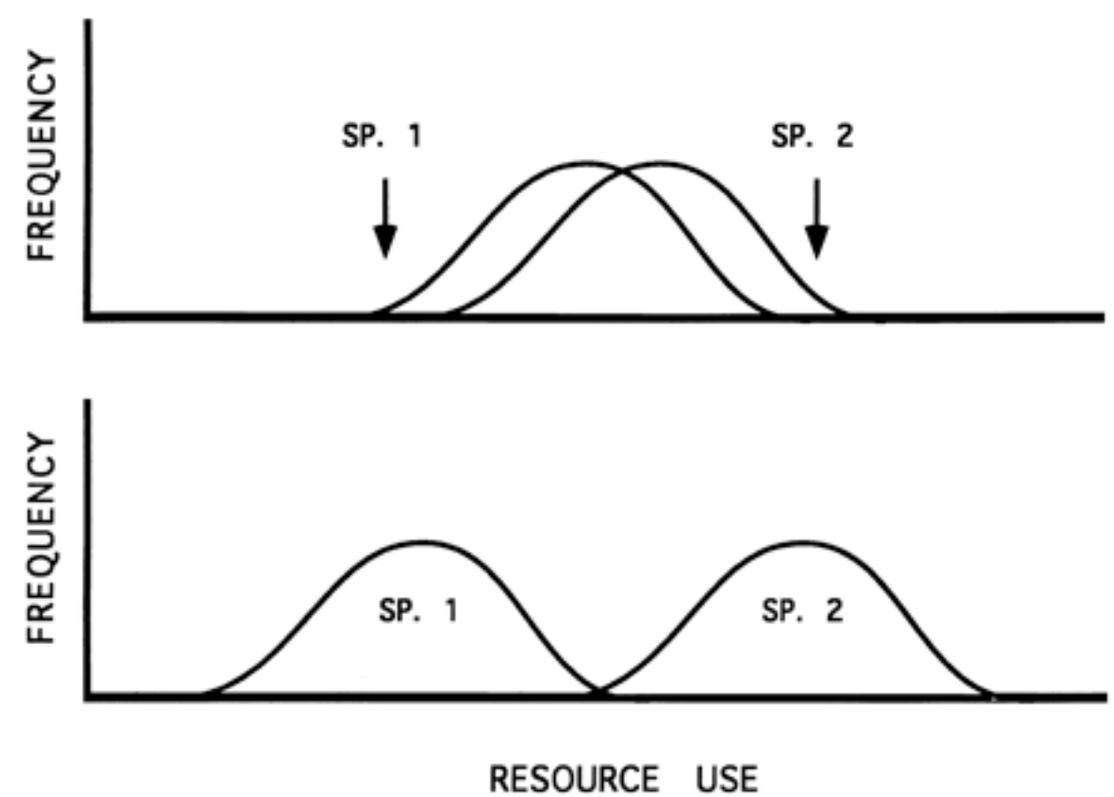
In high school, he discovered the first colony of imported fire ants in the United States — a species that went on to become a major pest in the South.

Graduate work: embarked on a long journey in 1953 to explore the global diversity of ants, starting in Cuba and moving on to Mexico, New Guinea and remote islands in the South Pacific.

In 1955 he completed an exhaustive taxonomic analysis of the ant genus *Lasius*.

Developed the concept of “character displacement,” in collaboration with W.L. Brown

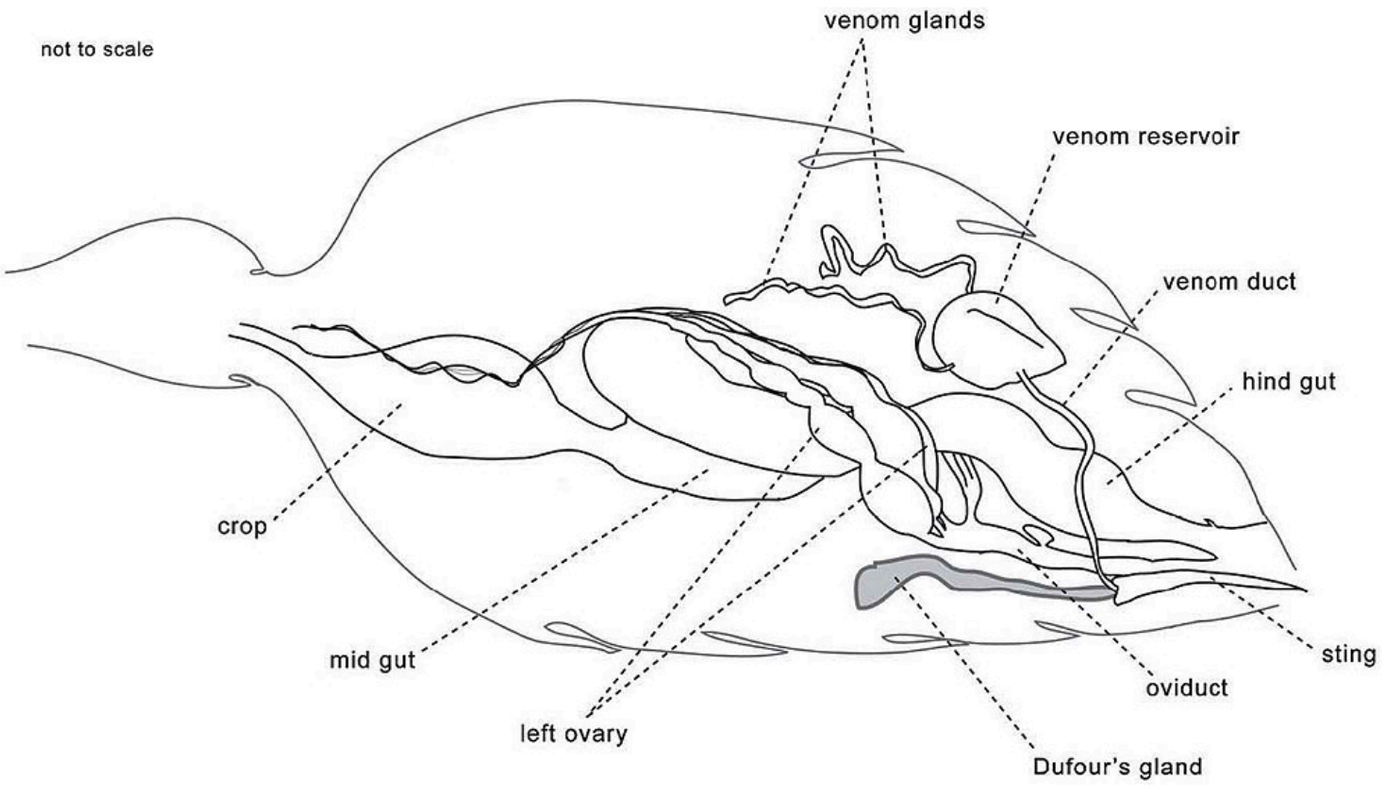
- -a process in which populations of two closely related species, after first coming into contact with each other, undergo rapid evolutionary differentiation
- -in order to minimize the chances of both competition and hybridization between them
- -differences between them are accentuated in the zone of sympatry and weakened or lost entirely in the parts of their ranges outside this zone



Wilson: The Ant Man

Early pioneer on understanding pheromones

noticed they tapped their abdomens down while walking
dissection uncovered the Dufour's gland



used for chemical trails to food

warning systems
search for enemy
attack!

many different colony level behaviors

mating chemical

Wilson: The Ant Man

GLANDULAR SOURCES AND SPECIFICITY OF SOME CHEMICAL RELEASERS OF SOCIAL BEHAVIOR IN DOLICHODERINE ANTS[1]

By Edward O. Wilson[2] and Mario Pavan[3]

Five organs in the abdomen are capable of emptying glandular secretions to the outside: (1) the hind-gut; (2) the paired "true" poison glands, with a large reservoir, the poison vesicle; (3) Dufour's gland (also called the accessory gland); (4) the anal glands, opening just above the anus; (5) the glandular "ventral organ" recently discovered by Pavan (1955). In a series of experiments, the five organs were dissected out of freshly killed workers, washed in insect Ringer's solution, and bioassayed with artificial trail tests. The results, summarized in table 1, show that the bulk, and perhaps the entirety, of the trail substance resides in the ventral organ. The occasional weak

Table 1. Results of artificial trail assay of selected abdominal organs of *Iridomyrmex humilis* workers.

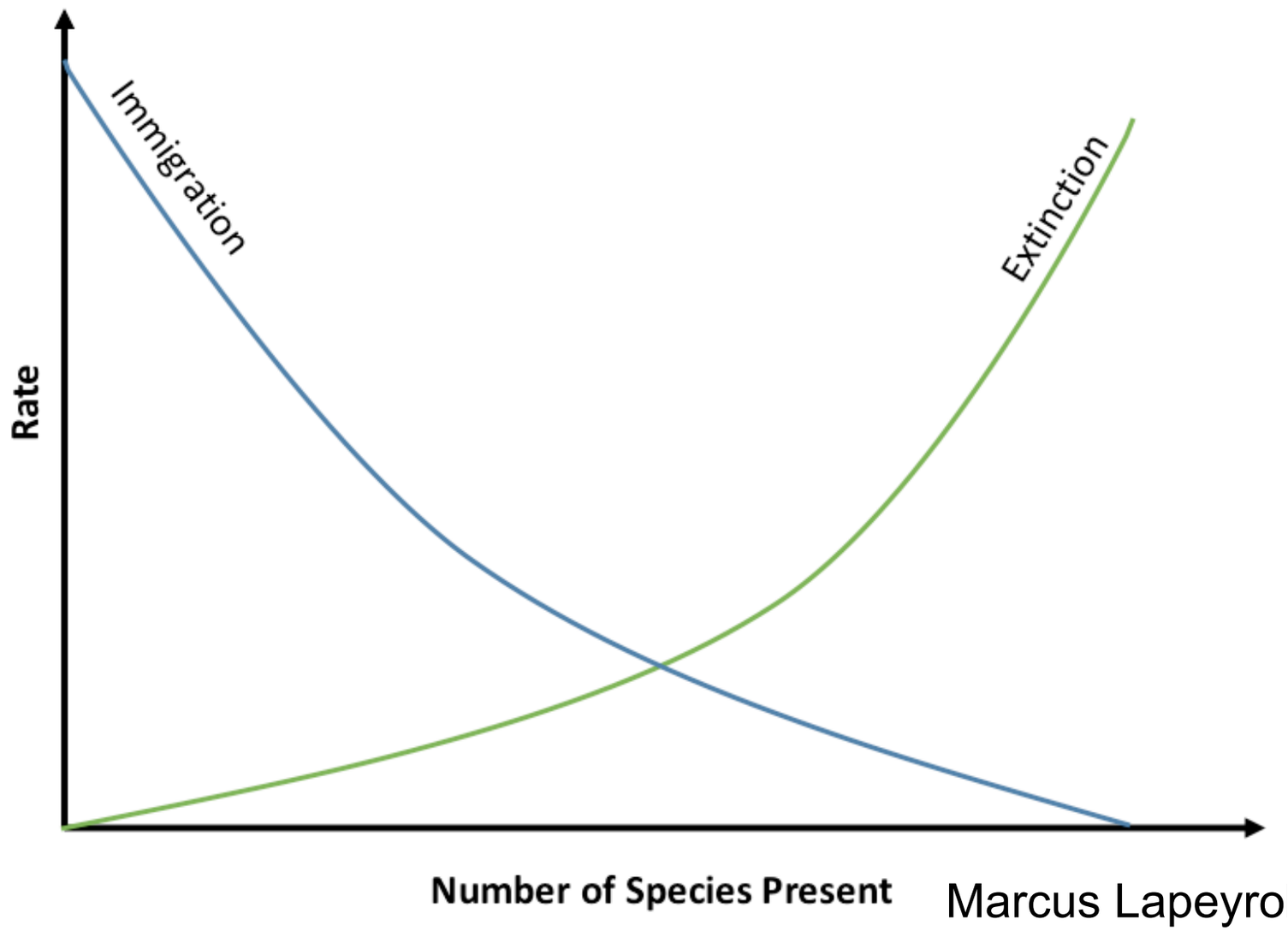
Organ	Number of tests	Number of positive responses*	Number of workers responding: range (with mean)	Duration of responses in minutes: range (with mean)
hind gut	6	0	0-2 (M<1)	0-1/2 (M<1/2)
true poison glands, plus reservoir	6	0	0-2 (M<1)	0-1/2 (M<1/2)
Dufour's gland	8	2	0-30 (M=8)	0-4 (M=1)
anal gland	5	1	0-15 (M=6)	0-1 (M=1)
ventral organ	7	7	65-339 (M=134)	2-9 (M=5)

* Positive responses are defined, arbitrarily, as the crossing of the trail midpoint by 10 or more workers.

"Wilson was thus the first investigator in the world to identify the basic system whereby ants communicate, an original and significant achievement. Along with that work in 1958 and 1959,he published more than 20 scientific and popular scientific papers in journals as diverse as *Science* (the premiere U.S. scientific journal), *Psyche* (a leading entomological journal), *Pacific Insects, Natural History, and Scientific American.*"

Wilson: The Ant Man

Basic hypothesis:
insular biota maintain a dynamic equilibrium between immigration and extinction rates, immigration rates are higher closer to mainland
Dr. Wilson and Dr. MacArthur published *The Theory of Island Biogeography* in 1967



Wilson: The Ant Man

Tested on site with graduate student Daniel Simberloff

—tiny mangrove islets, some just a few feet across, in the Florida Keys

—temporarily gassed the arthropods

—removed the snails

—tracked immigration

fit the model

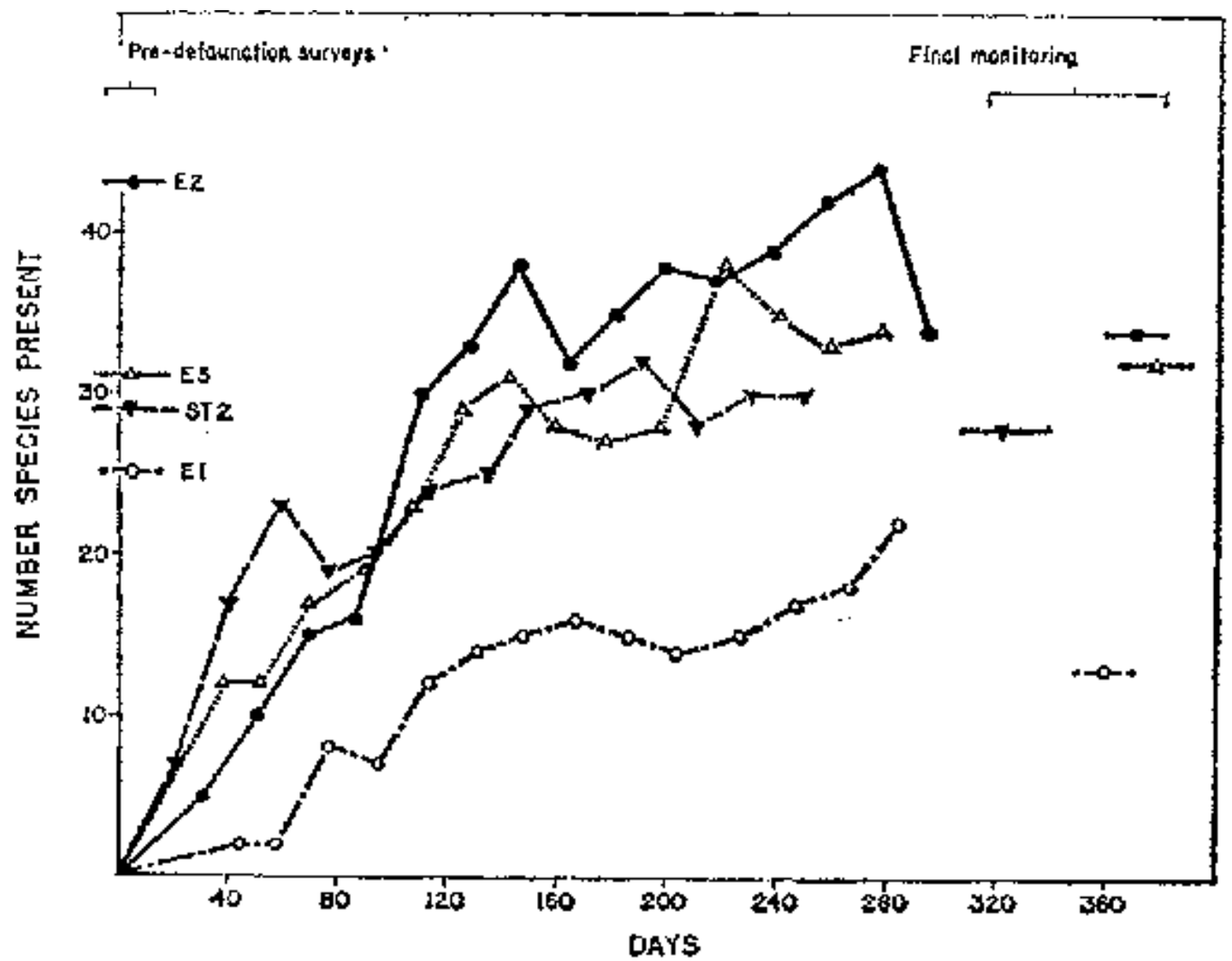
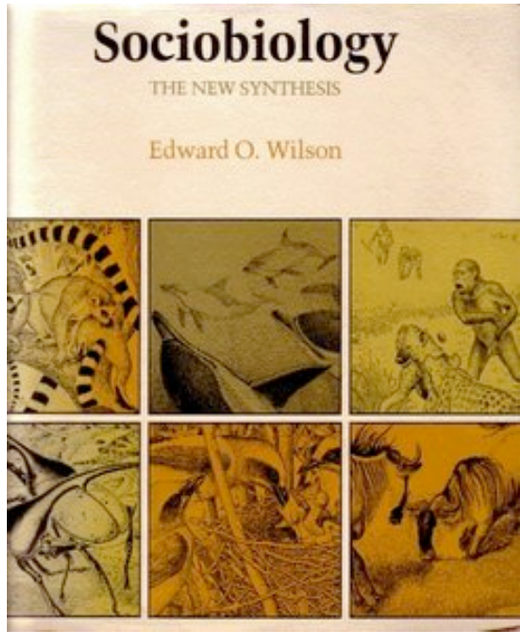


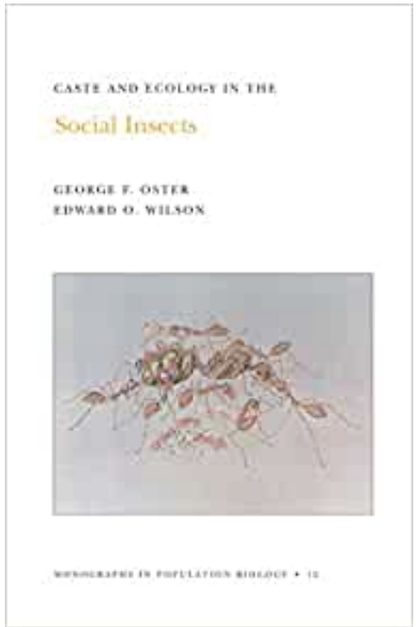
FIG. 1. The colonization curves of the experimental

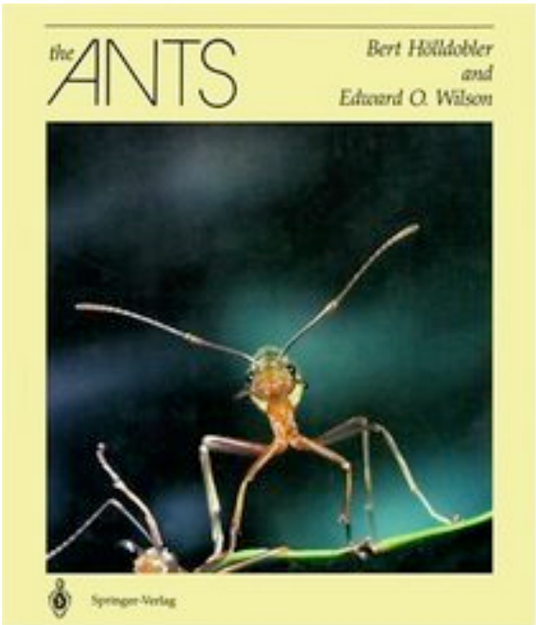
Simberloff, Daniel. "Experimental zoogeography of islands: effects of island size." Ecology 57.4 (1976): 629-648.

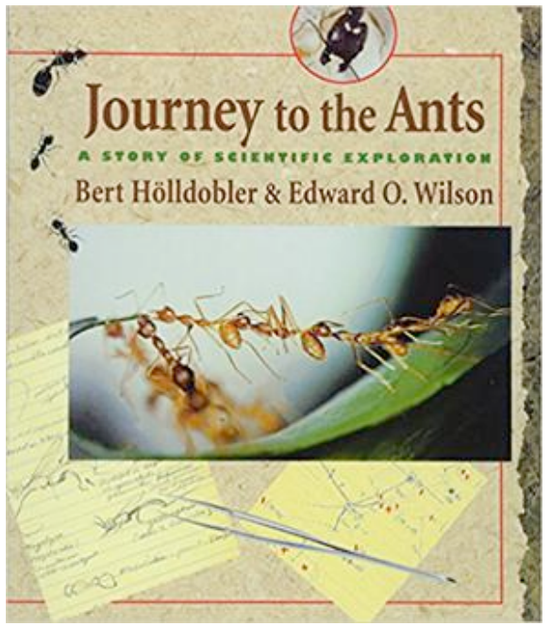
Wilson: The Ant Man

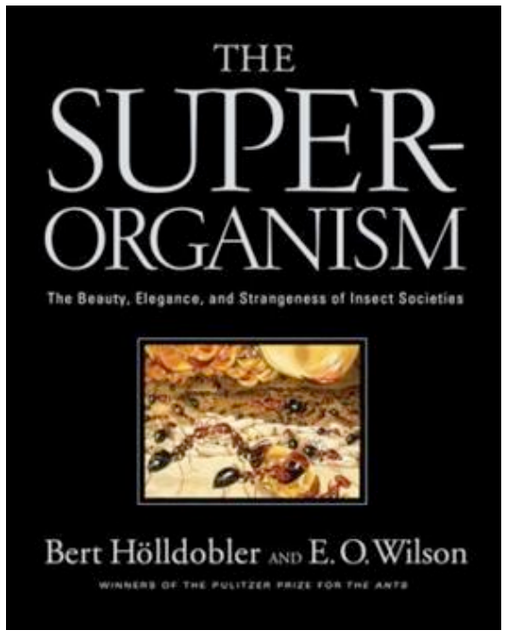
Insect Societies (1971)
Sociobiology (1975)
Caste and Ecology in the Social Insects (1978) coauthored with mathematical biologist George Oster
The Ants (1990) co-authored with entomologist Bert Hölldobler [Pulitzer Prize winner]
Journey to the Ants (1994)
The Superorganism (2009) also Bert Hölldobler











Wilson: The Ant Man

Insect Societies — Sociobiology — Caste and Ecology in the Social Insects — The Ants — The Superorganism

Examination of insects with a focus on ants regarding social structure, altruism, special genetics, and cooperative behavior

Queens: reproductive females
Workers: non-reproductive (sterile) females
Males: fertile

colonies of individuals, formed by altruistic cooperation, complex communication, and division of labor—represent one of the basic stages of biological organization aka "superorganism"

Wilson: The Ant Man

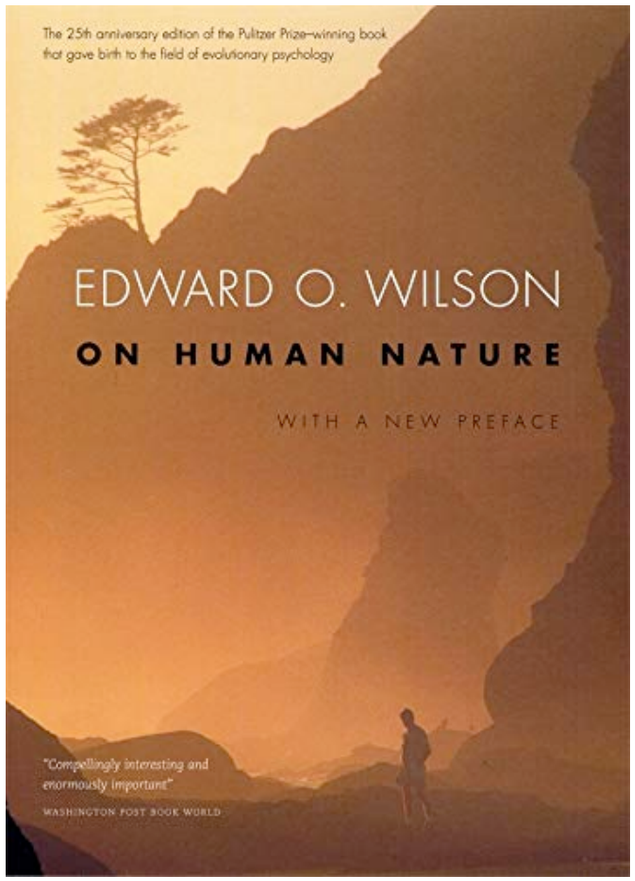
*Insect Societies — **Sociobiology** — Caste and Ecology in the Social Insects — The Ants — The Superorganism*

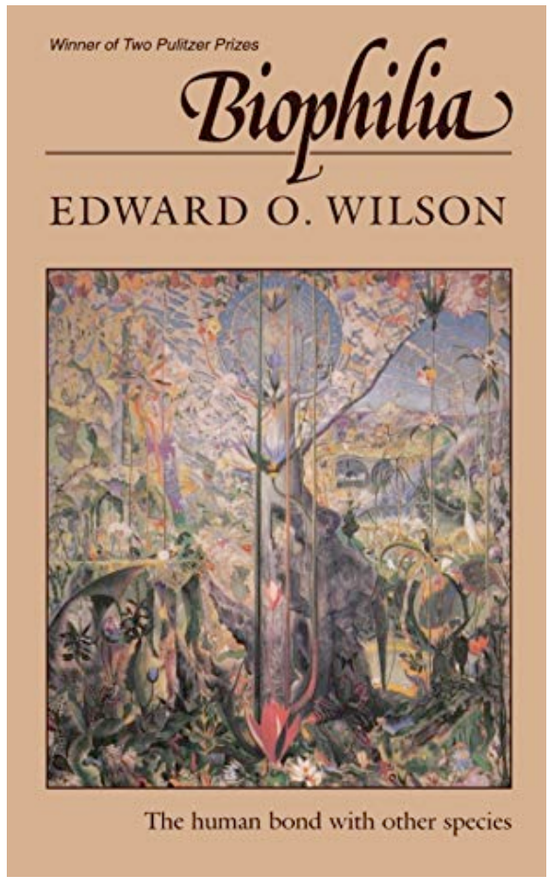
Application to animal behavior was a conceptual leap forward for behavioral scientists

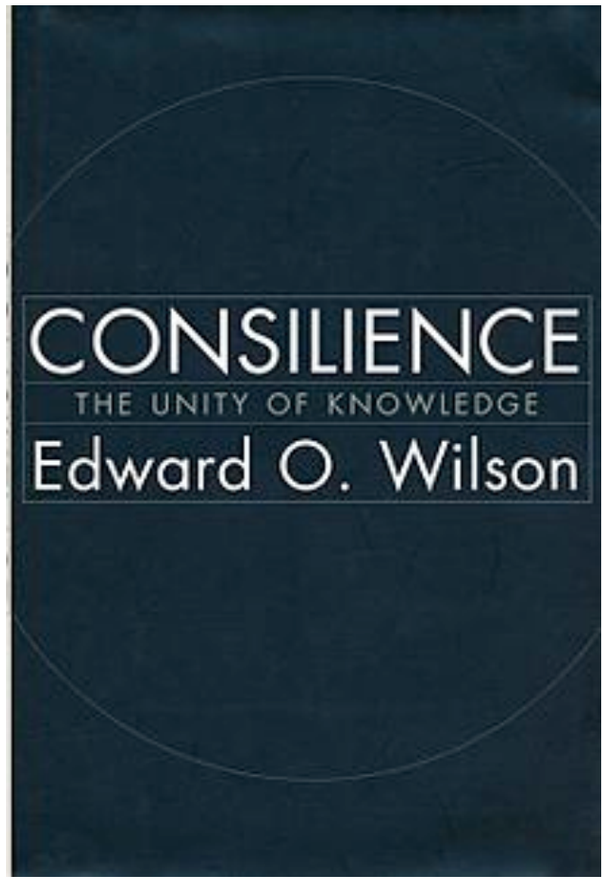
Unsurprisingly, the human part kicked off some debate

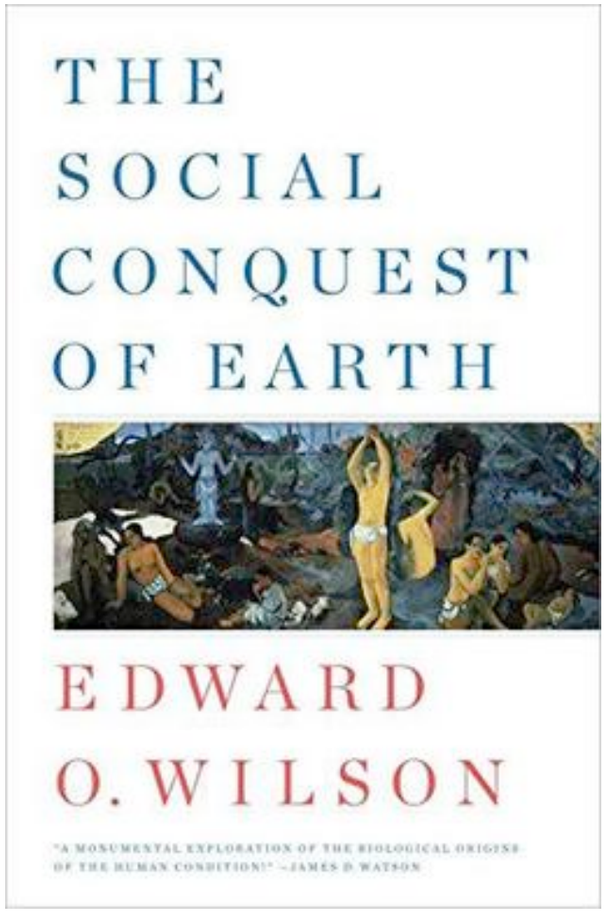
Wilson: The Sociobiologist

On Human Nature (1978) [Pulitzer Prize winner]
Biophilia (1984)
Consilience: The Unity of Knowledge (1998)
The Social Conquest of Earth (2012)









Wilson: The Sociobiologist

On Human Nature — Biophilia —Consilience: The Unity of Knowledge — The Social Conquest of Earth

—Genetics remains a driving force for human decision making in programming the brain with algorithms that *bias* decisions if not hard coded
—Society can have “biological properties”
—Purpose of sex for reproduction only is misguided, homosexual acts can have purposeful roles in society
—Altruism, and its veneration, benefits societies
—Religion is a unique subversion of individual goals to the group, and the tension between it and rationalism is an ongoing source of tension

—human appreciation for diverse nature is a biological adaptation
—"the urge to affiliate with other forms of life"

—an attempt to create a unified framework for science and humanities

—argument for eusocial behavior as group selection over kin selection theory

Wilson: The Sociobiologist

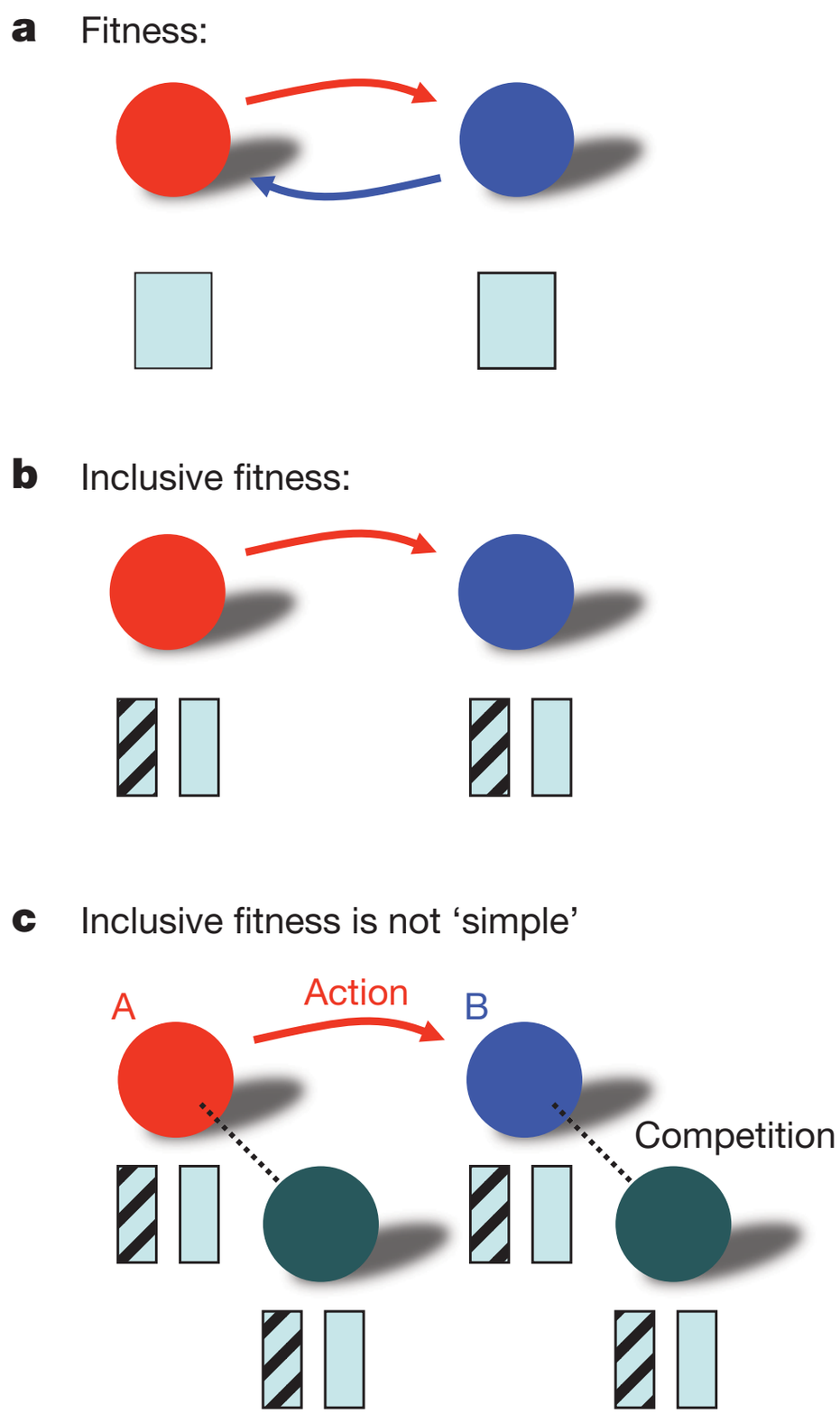
Nowak, M., Tarnita, C. & Wilson, E. “The evolution of eusociality.” *Nature* 466, 1057–1062 (2010)

“The pivotal idea expressed by both writers was formalized by Hamilton as the inequality $R = c/b$, meaning that cooperation is favoured by natural selection if relatedness is greater than the cost to benefit ratio.” hence kin-selection or inclusive fitness makes sense

“‘haplodiploid hypothesis.’ : the sex- determining mechanism in which fertilized eggs become females, and unfertilized eggs males. As a result, sisters are more closely related to one another ($R = 3/4$) than daughters are to their mothers ($R = 1/2$).”

in this work, authors argue this ends up being demonstrated as exceptionally rare overall, many examples of altruism in non-haplodiploid species, species can show aggregation behaviors without evolving altruism

Wilson: The Sociobiologist



basic point — as one also considers all the competitive interactions between individuals, inclusive fitness theory can only model and have explanatory power for special instances

developed improved mathematical models in which group selection theory is better

kinship also favors less genetic diversity which is anathema to natural selection over long periods of time

fits standard evolutionary theory as applied to groups

Figure 3 | The limitation of inclusive fitness. a, The standard approach of

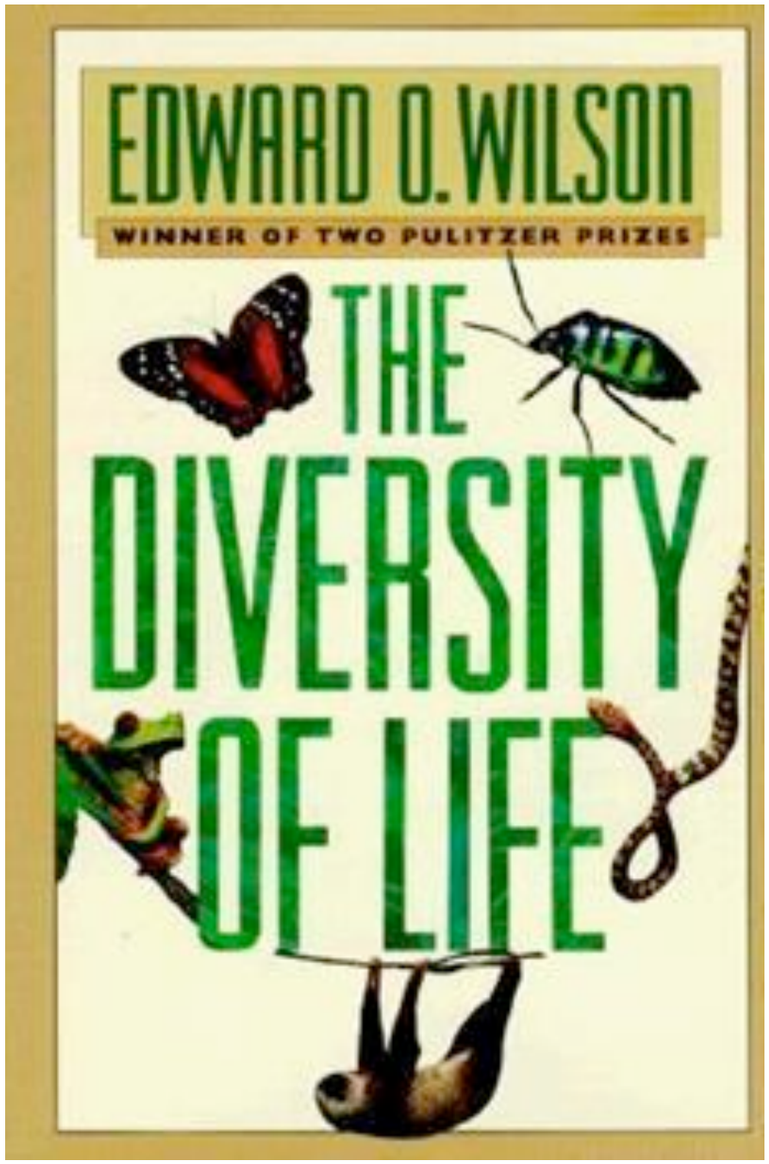
Wilson: The Sociobiologist

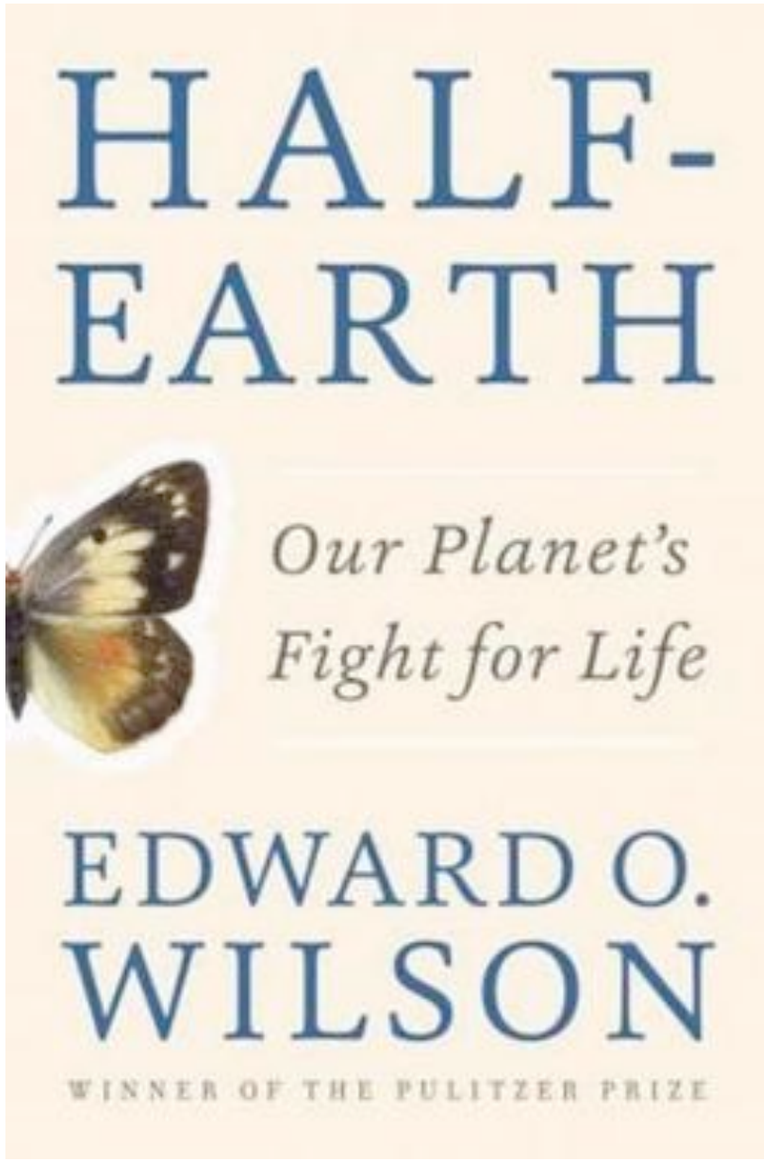
Evolutionary psychology, which emerged in the late 1980s, is a synthesis of developments in several different fields, including ethology, cognitive psychology, evolutionary biology [sociobiology], anthropology, and social psychology.

Wilson: The Biophiliac

The Diversity of Life (1992)

Half-Earth (2016)





Wilson: The Biophiliac

The Diversity of Life — Half-Earth

Discussing the 6th great extinction
Biological diversity has multiple values to humans

https://eowilsonfoundation.org/the-diversity-of-life/

The E.O. Wilson Biodiversity Foundation's mission is to foster a knowing stewardship of our world through biodiversity research and education initiatives that promote and inform worldwide preservation of our biological heritage. We believe that by enhancing our public understanding of biodiversity, we can foster a culture of stewardship in which people are inspired to conserve and protect the natural world.

proposed that half of the Earth's surface should be designated a human-free natural reserve to preserve biodiversity

with Ehrlich co-founded the Half-Earth Project in 2016
https://www.half-earthproject.org/

Encyclopedia of Life - Global access to knowledge about life on Earth
https://eol.org/

half-earth project

Find places

EXPLORE AREAS

MAPPING 1

Biodiversity

PRIORITY | RICHNESS | RARITY

WHERE TO START TO PROTECT?

HIGH PRIORITY

The priority layer indicates the minimum amount of additional global conservation needed to protect the bulk of terrestrial vertebrate biodiversity, with locations identified via spatial conservation planning. It presents one possible pathway of many toward comprehensive terrestrial biodiversity conservation. Locations with higher values indicate places of higher priority for conservation that contribute more to the safeguarding of species habitat.

LOW PRIORITY

Source: Rinnan DS and Jetz W 2020; Rinnan DS et al. 2021 (Map of Life - Yale University)

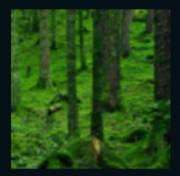
GLOBAL TERRESTRIAL VERTEBRATE PRIORITY

low — high

half-earth project

Global, *55 km cell size mapping of marine species.

- All Marine Vertebrates
- Fishes
- Mammals



MAPPING 1

Existing protection

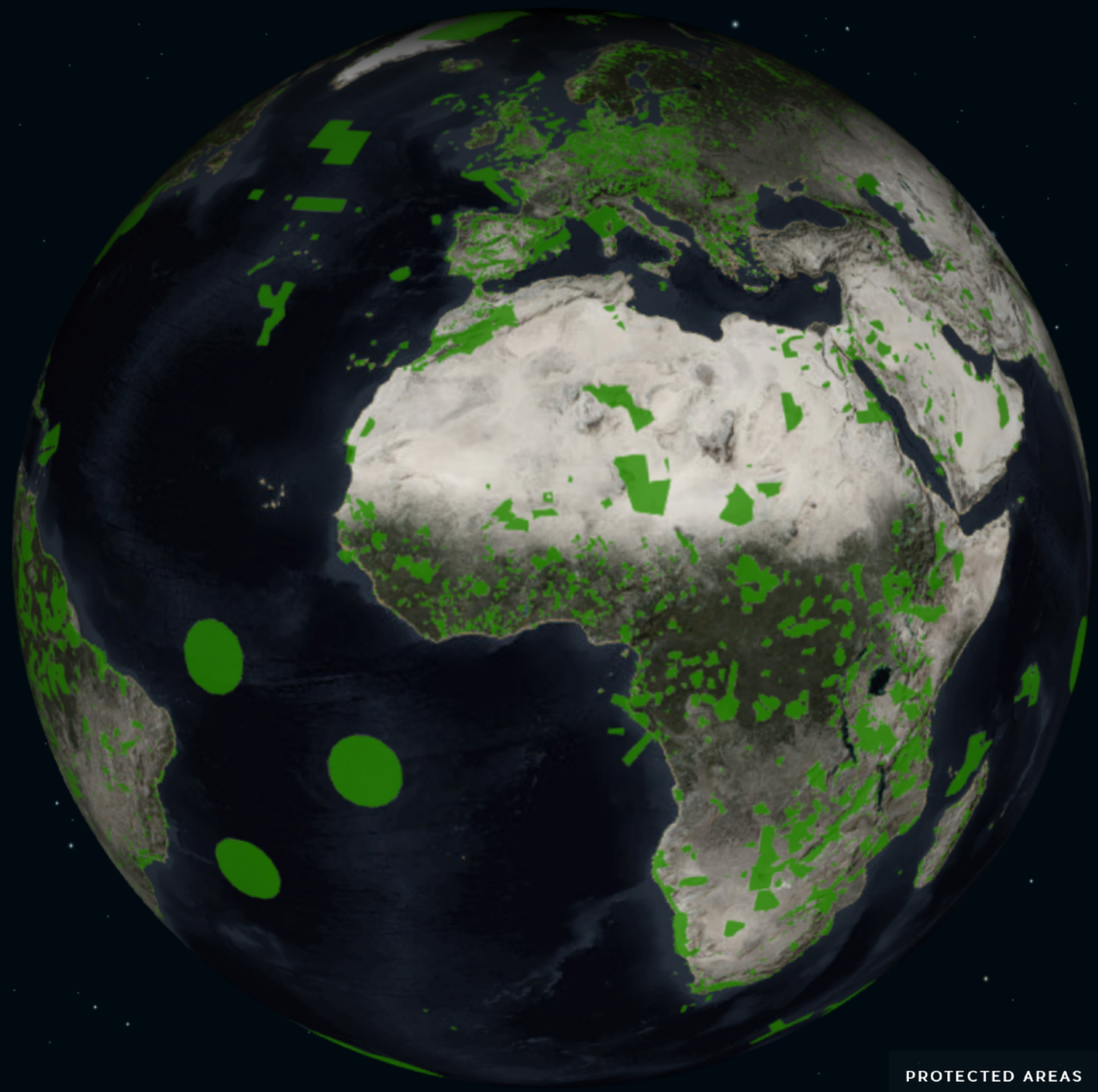
CONSERVATION AREAS

Protections classified according to their management objectives.

- [x] Protected areas
- [ ] Community-based

MAPPING

Human pressures



PROTECTED AREAS

Protected Areas

half-earth project

protection

CONSERVATION AREAS

Protections classified according to their management objectives.

- [ ] Protected areas
- [ ] Community-based

MAPPING 2

Human pressures

LAND USE PRESSURES

Human pressures causing habitat loss and accelerating species extinction.

- [x] Urban pressures
- [ ] Rainfed agriculture
- [ ] Irrigated agriculture
- [ ] Rangeland

OCEAN USE PRESSURES

Human pressures causing habitat loss and accelerating species extinction.

- [ ] Land-based drivers
- [ ] Ocean-based drivers
- [x] Commercial fishing
- [ ] Artisanal fishing

COMMERCIAL FISHING

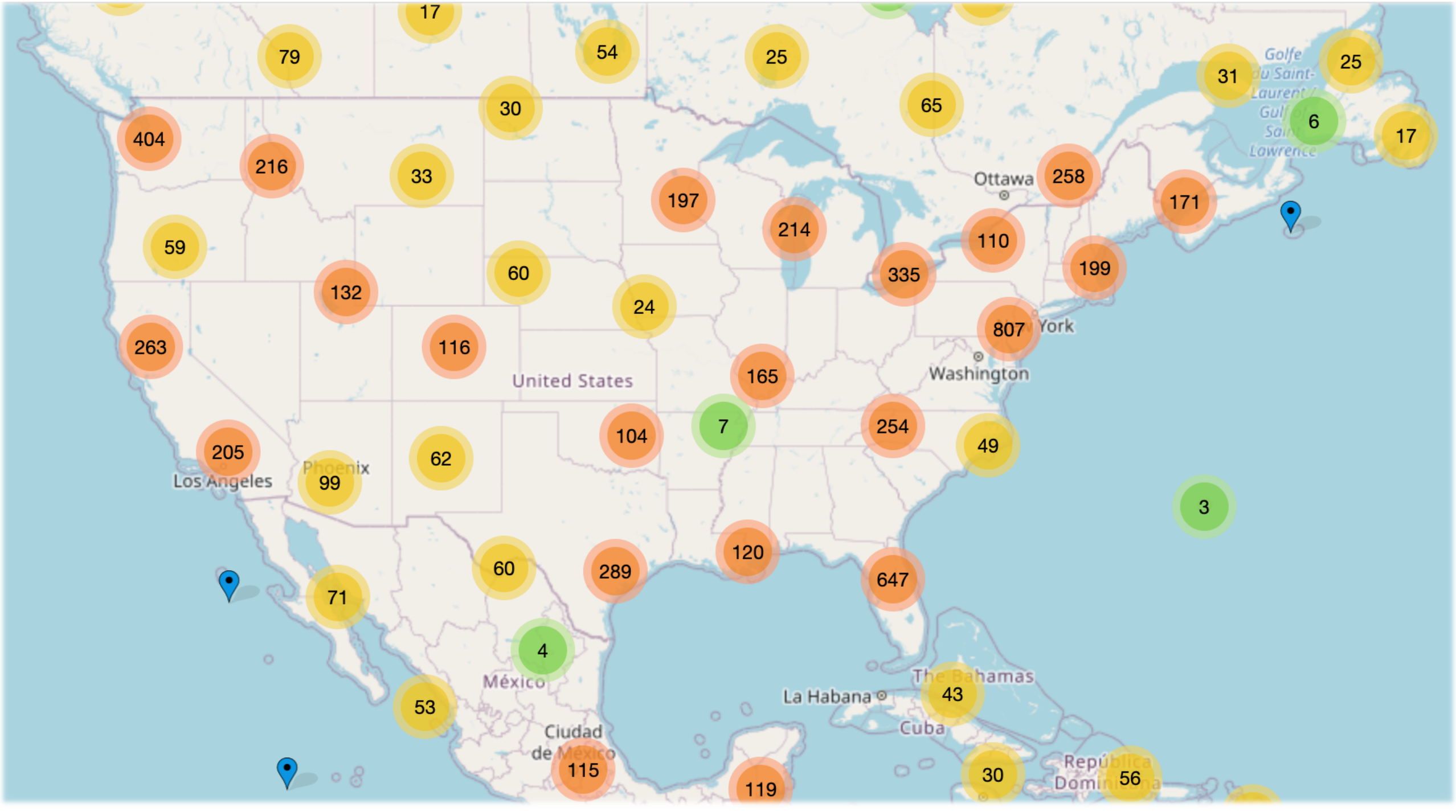
low — high

URBAN PRESSURES

low — high

Osprey

Pandion haliaetus (Linnaeus 1758)



Wilson: The Teacher

E.O. Wilson's Life on Earth

https://eowilsonfoundation.org/e-o-wilson-s-life-on-earth/

Free iPad Biology Textbook. Multimedia and interactive

To "see," for example, the chemical environment of organisms, such as the plumes of **pheromone** and territory-marking molecules that organisms use to communicate. Ants have been the study of a lifetime for Edward O. Wilson. We'll bring some special lessons to students from the world of ants.

Movie 4 Chemical Language of Pheromones

Ants communicate using combinations of ten to twenty chemical signals.

In July and August of 2011 the team filmed in Gorongosa National Park in the southern African nation of Mozambique, bringing home feature material for four chapters in ecology. While shooting in the rain forest atop Gorongosa Mountain, we spent a little time collecting. The carpenter ant to the left, collected on our trip, is a species of the genus *Camponotus* that was previously unknown to science.

Our goal is to have students see the living world the way a naturalist sees it.

Interactive 6 Insect Body Plan

The word insect *is derived from the Greek meaning "cut into sections." The evolutionary success of insects and their distinctive physiology can be measured by this: as much as 90 percent of all animal species are insects.*

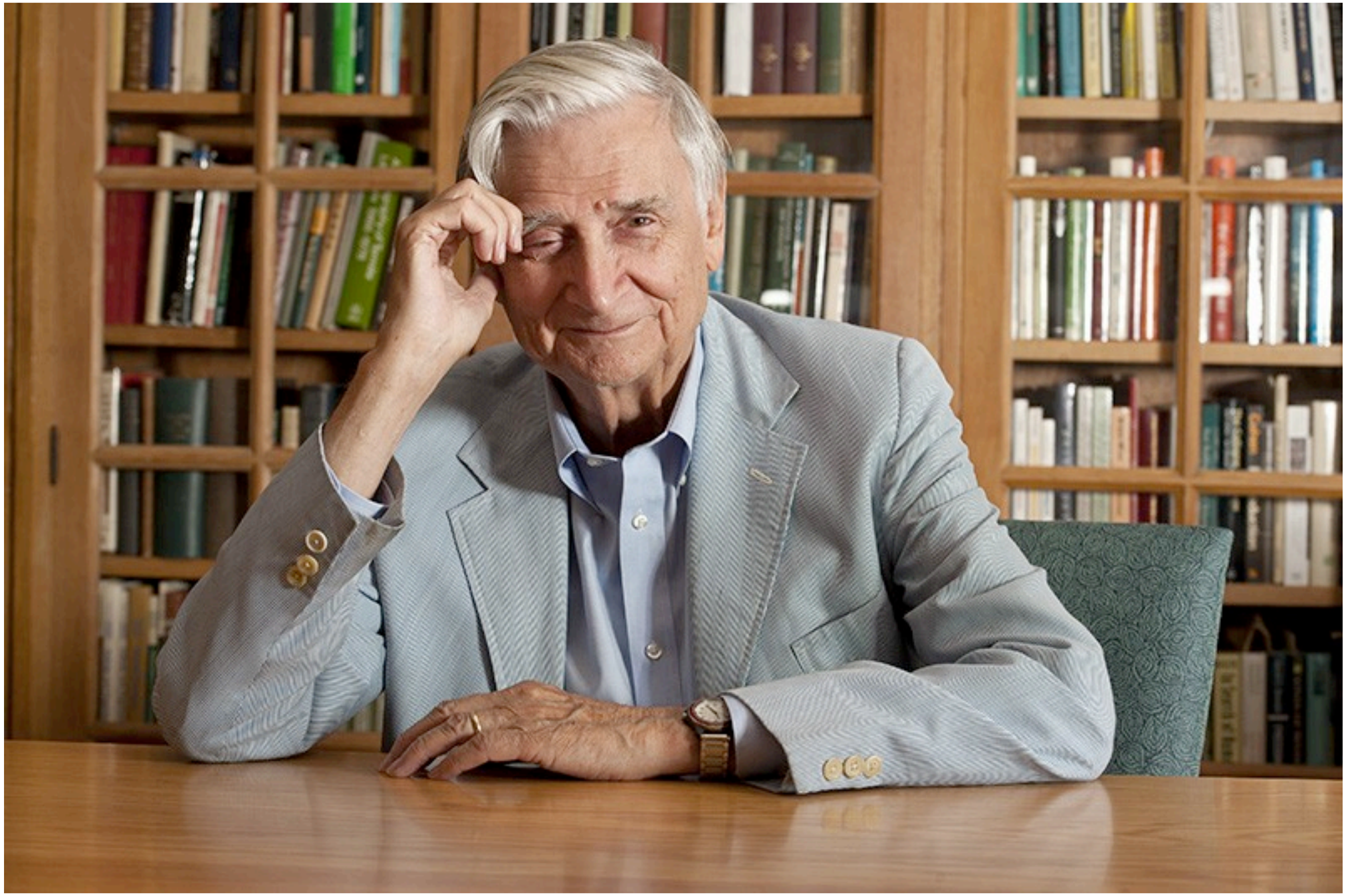
Wilson: as Self

2015 *E.O. Wilson: Of Ants and Men (Documentary)*

1995-2008 *Nova (TV Series documentary)*
- *Lord of the Ants (2008)*
- *Master of the Killer Ants (2007)*
- *Little Creatures Who Run the World (1995)*

2006 *Planet Earth: The Future (TV Series documentary)*
- *Into the Wilderness (2006)*
- *Saving Species (2006)*

Heroes of Evolution 2022



Harvard University Professor E.O. Wilson in his office at Harvard University in Cambridge, MA. USACredit: Rick Friedman/Corbis via Getty

Nature OBITUARY 10 January 2022 Edward O. Wilson (1929–2021)