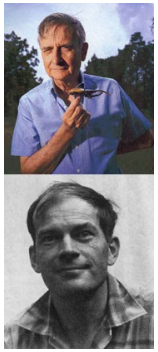
Experimental Biogeography of Islands

Reading: Simberloff & Wilson

The Importance of Islands – Islands as Natural Laboratories

Lecture 19 Recap



Wilson &
MacArthur

The Importance of Islands – Islands as Natural Laboratories

- *Natural Laboratories*

- Natural systems where key factors vary so that their effects can be isolated

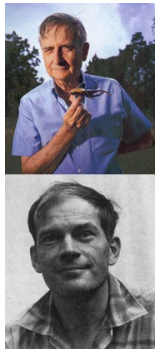

Olof Arrhenius

The Importance of Islands – Islands as Natural Laboratories

- *Species vs. Area Relationship*
- As area increases there tends to be more species
- Saturating function can be transformed to a first order function (linear) using Arrhenius plots (log-log)
- Noticed that the slope of the line appeared to differ systematically between islands and non-isolated areas on continents

The Importance of Islands – Islands as Natural Laboratories

- In oceanic islands, species richness declines with distance from a mainland source
- Traditional explanation was impoverishment with distance, which held that time had been insufficient for remote islands to fill up
- Implication that over time the species richness of these islands would increase further
- This is a *non-equilibrium* explanation



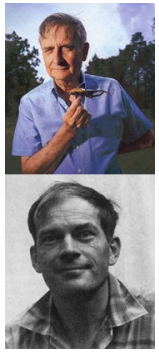
Wilson & MacArthur

The Importance of Islands – Islands as Natural Laboratories

- *An Equilibrium Theory of Insular Zoogeography*

- The authors argued for an equilibrium model of species richness along a distance gradient from the mainland sources, and that this was also a function of island size

- This theory represents a dynamic steady state due to the offsetting effects of immigration (influenced by distance) and extinction (influenced by area)



Wilson & MacArthur

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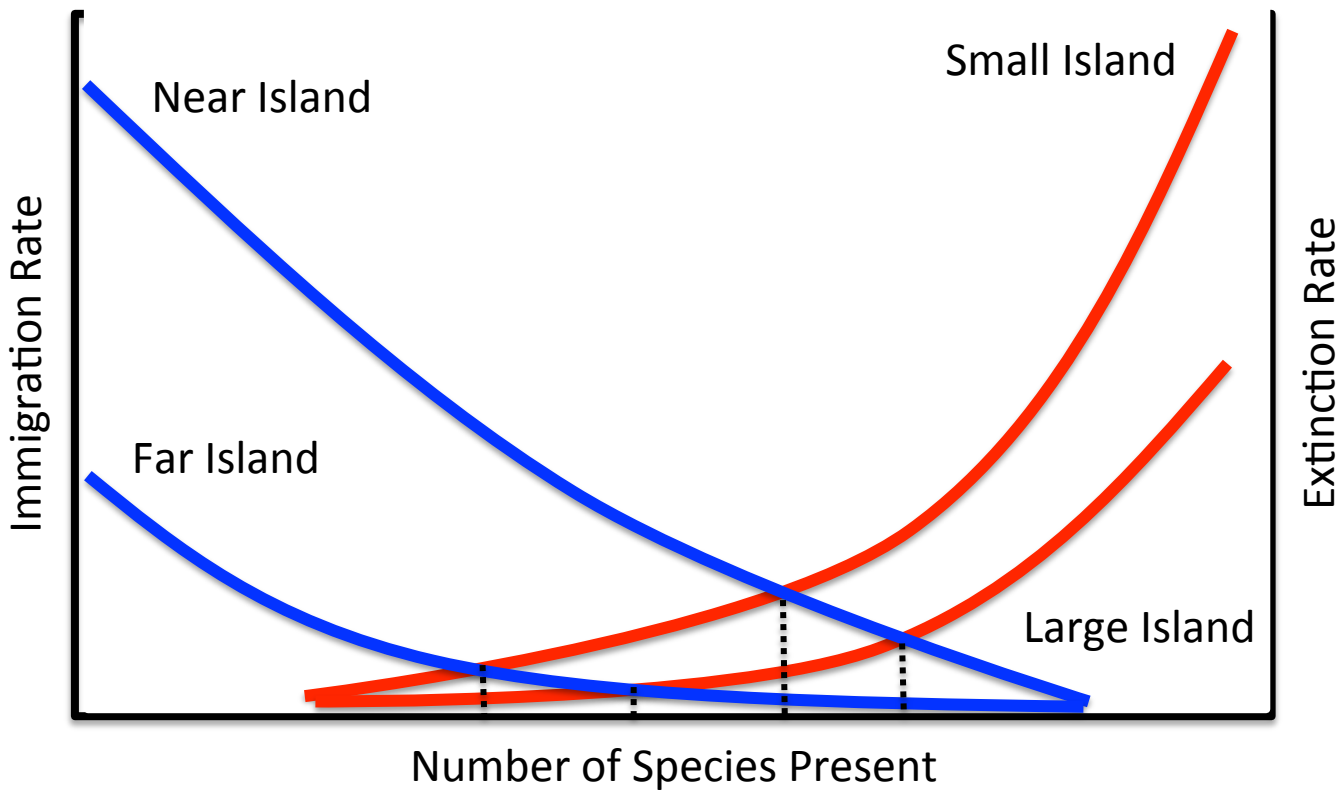

The Importance of Islands – Islands as Natural Laboratories

- MacArthur & Wilson introduced the the equilibrium theory of island biogeography
- How do we know if species richness on islands follows an equilibrium (steady state) or non-equilibrium (gradual increase with time) model?
- Design and implement an experiment to test your hypothesis

Simberloff & Wilson

The Importance of Islands – Islands as Natural Laboratories

- *Experimental Zoogeography of Islands. A Two-Year Record of Colonization*

- Wilson and his graduate student, Daniel Simberloff, set out to test the equilibrium theory of island biogeography developed by MacArthur and Wilson

- They did this by observing the immigration and extinction of species on small mangrove islands

Simberloff & Wilson

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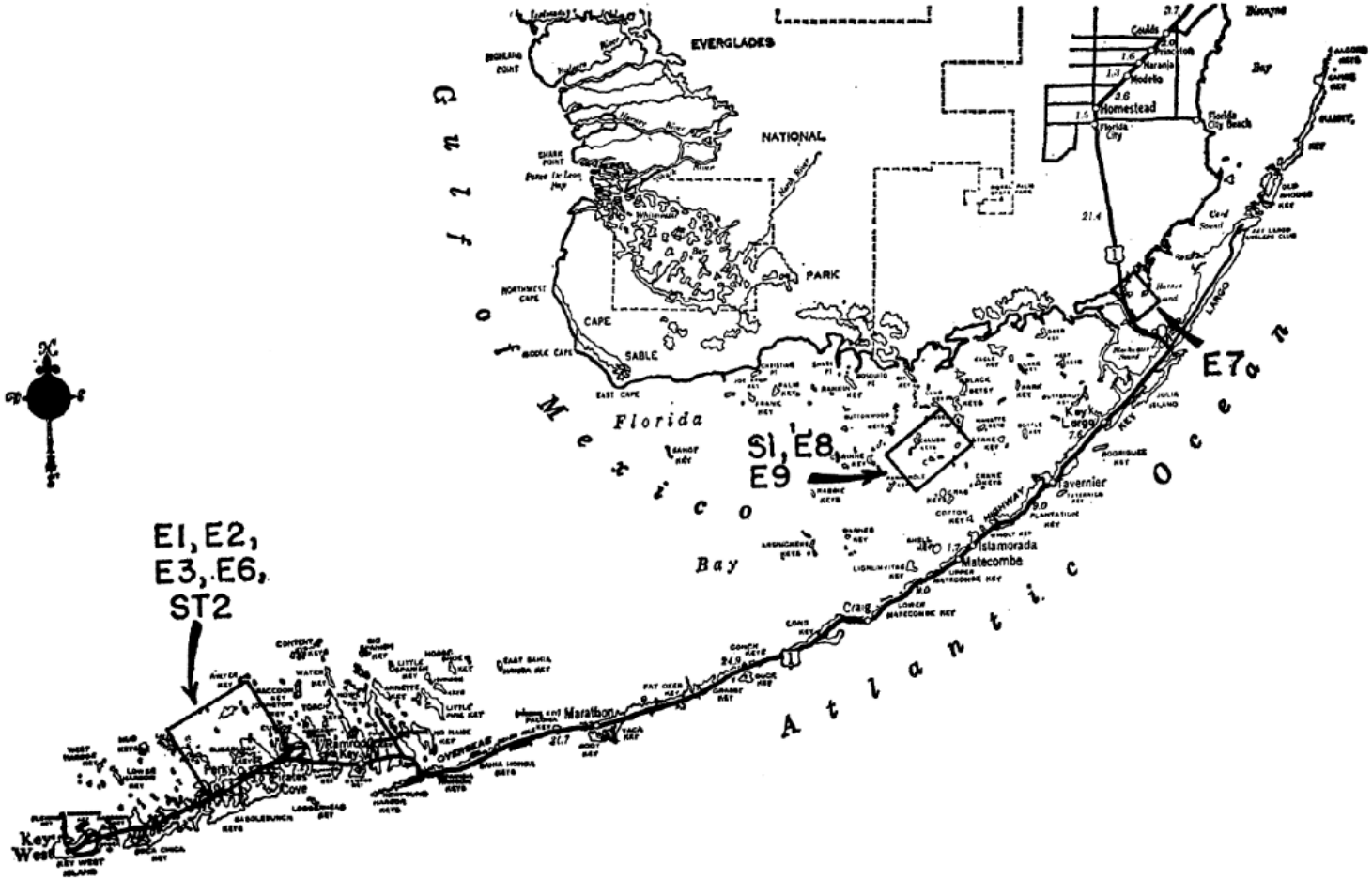

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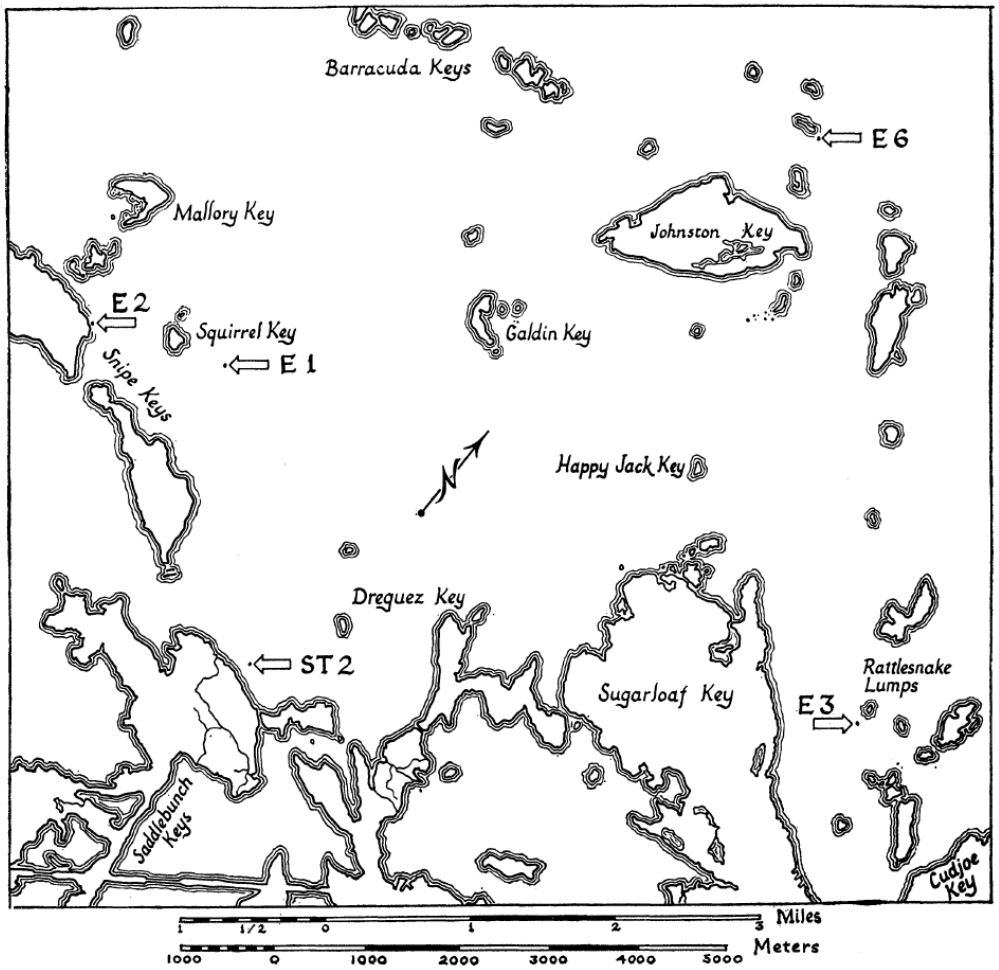

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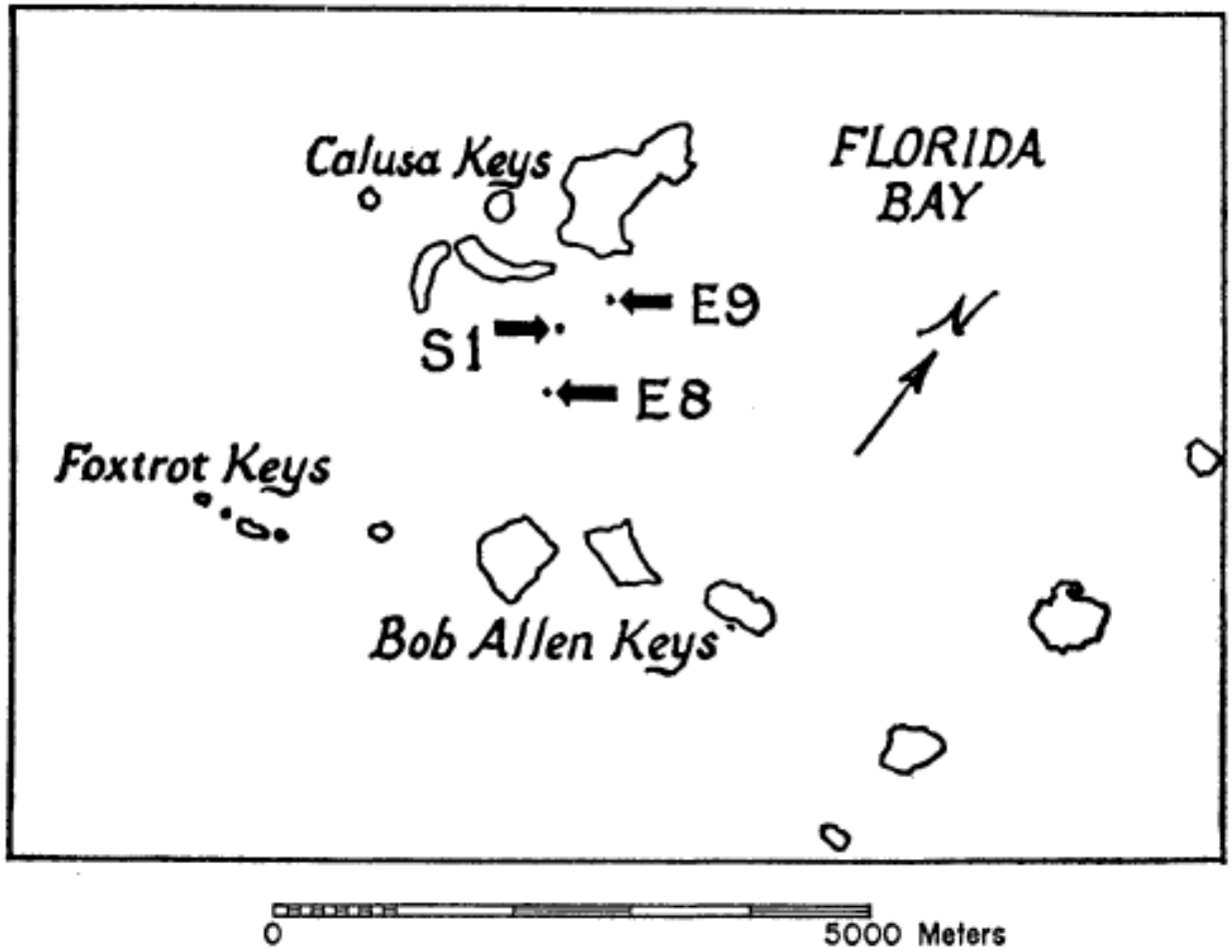

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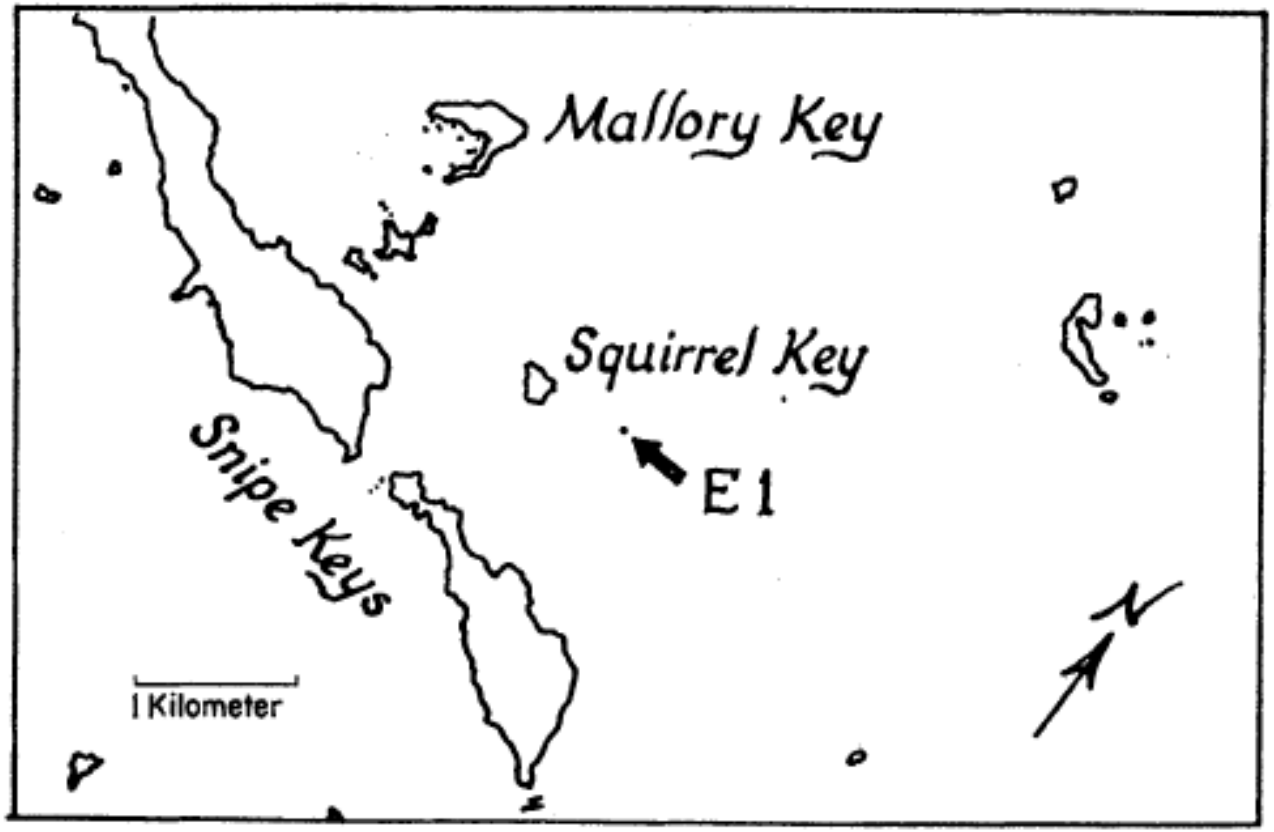

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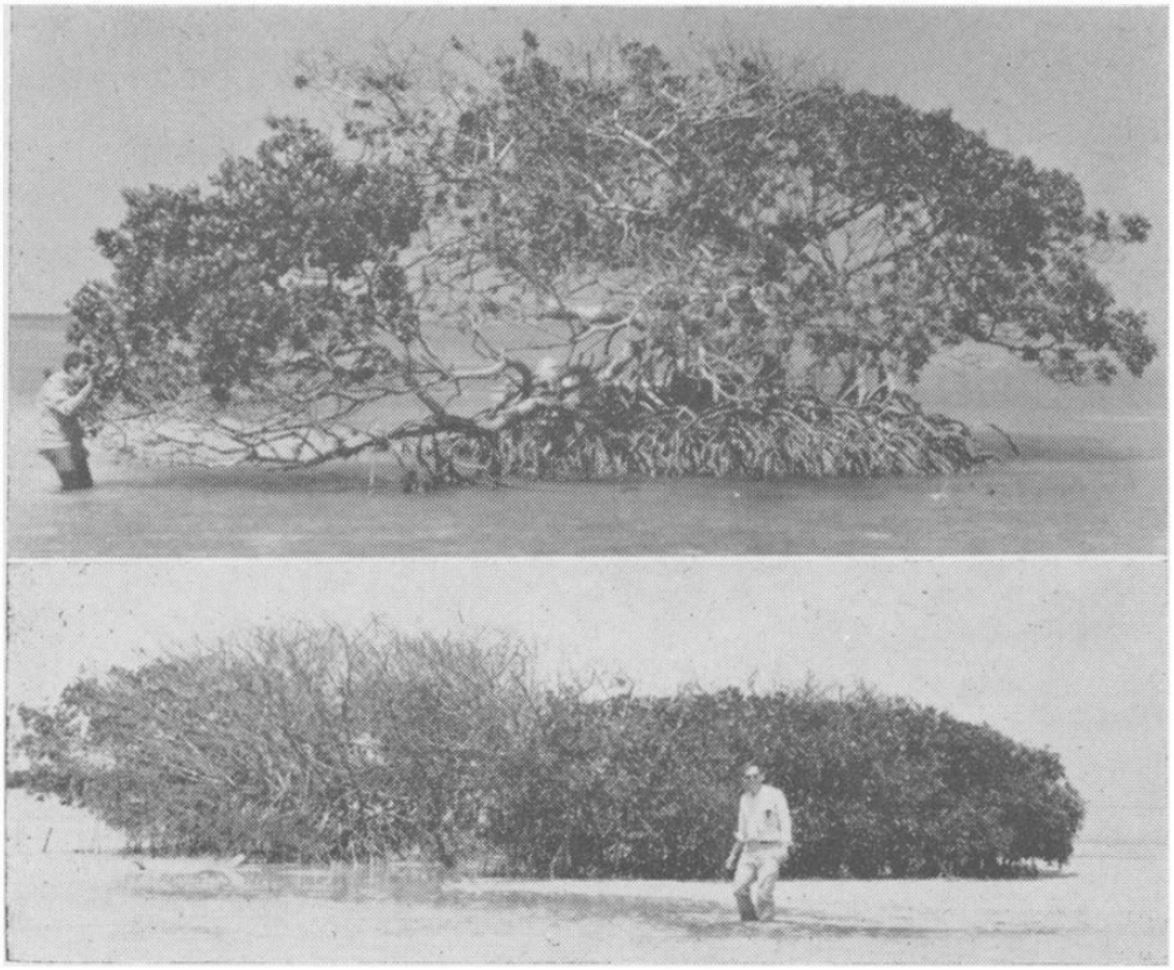

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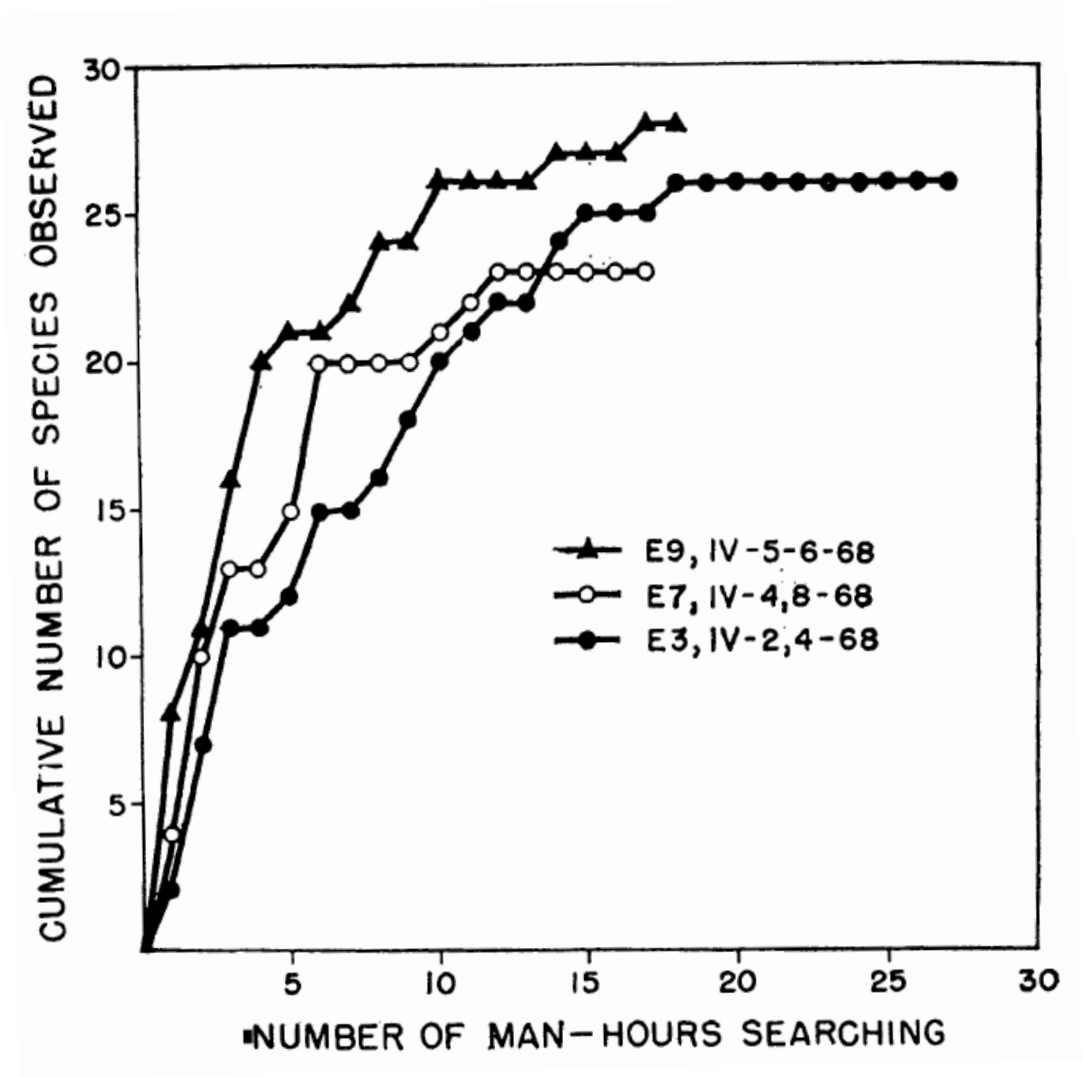
- The authors first assessed all the species of arthropods on each island

- They then surrounded each island with rubberized nylon sheeting and fumigated to remove all invertebrate life

Simberloff & Wilson

The Importance of Islands – Islands as Natural Laboratories



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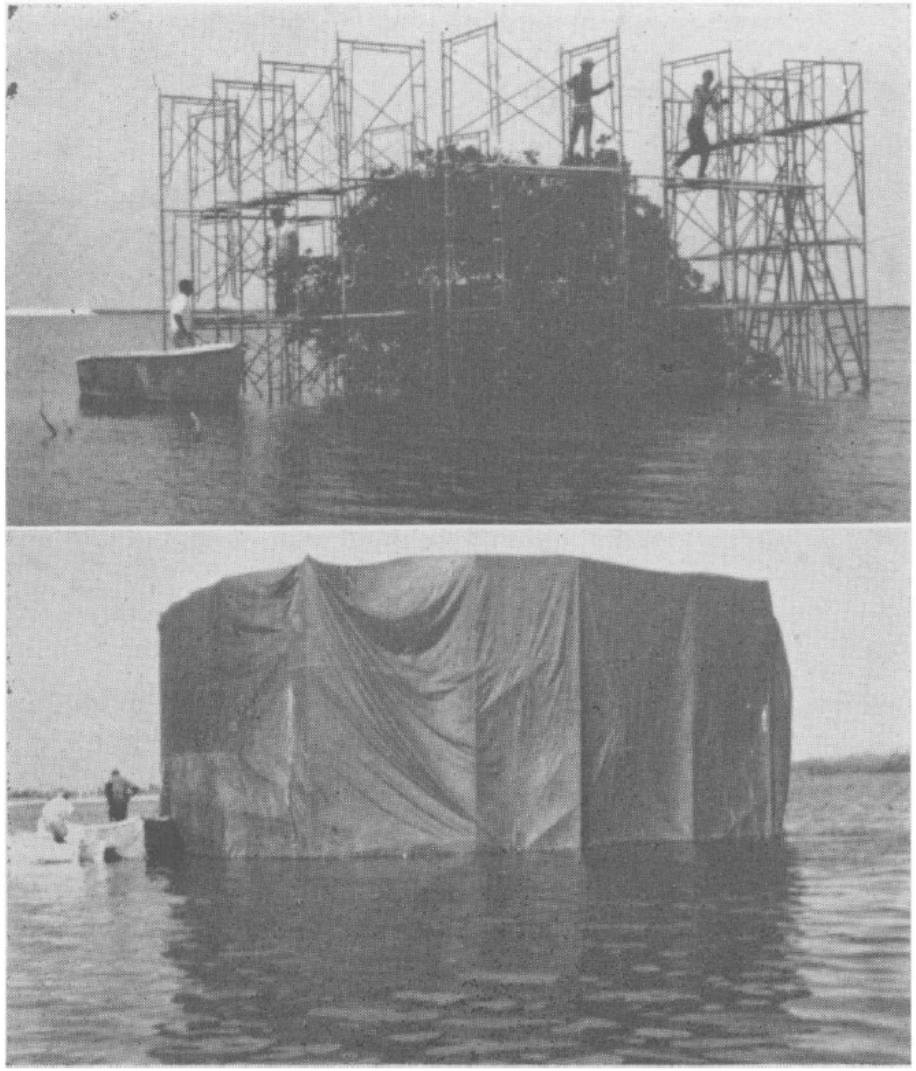

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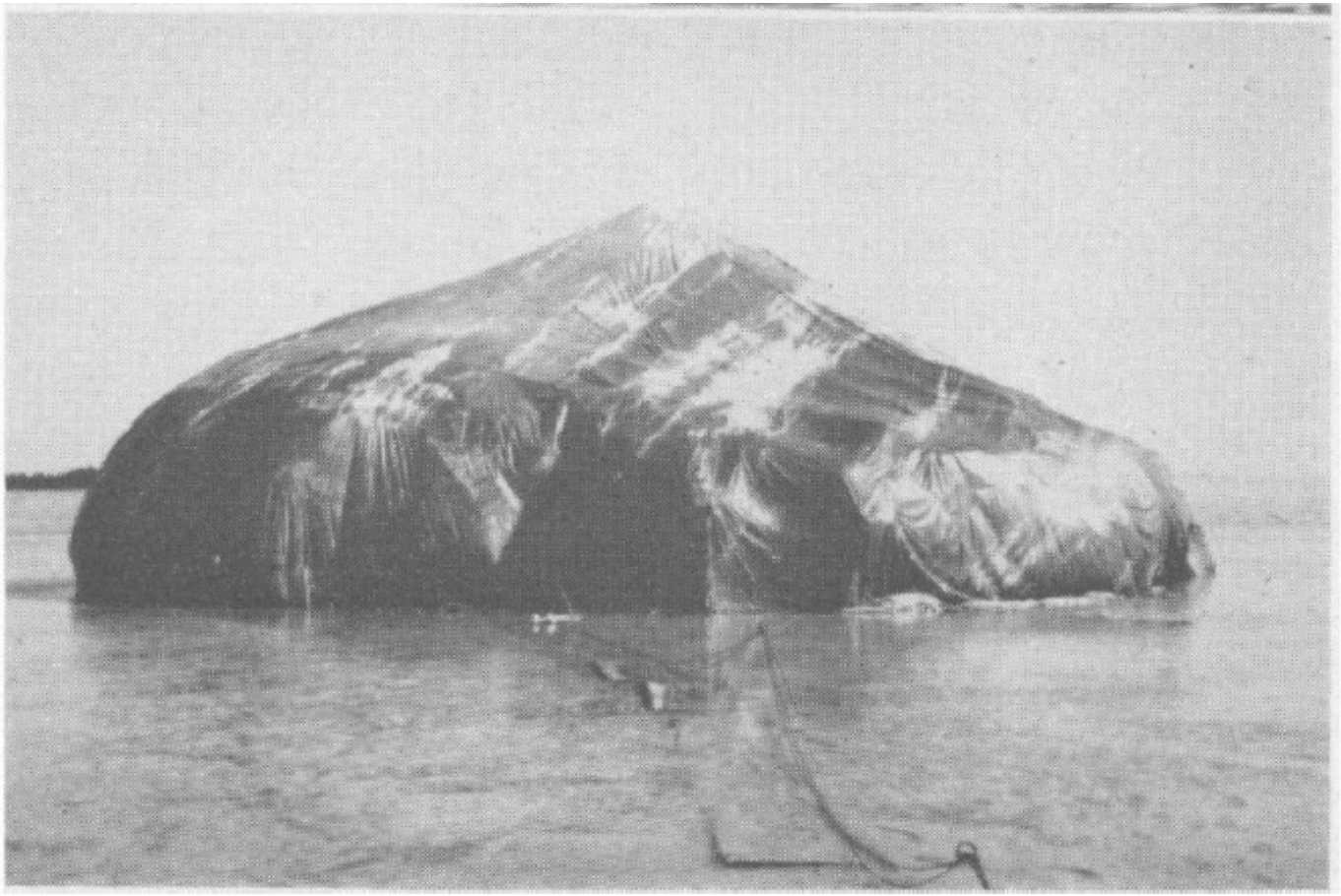

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- After the fumigation, arthropod species were assessed every 2 weeks
- The authors published the work as several papers in an issue of *Ecology* after the first year
- They then returned after 2 years to see how the island communities had changed

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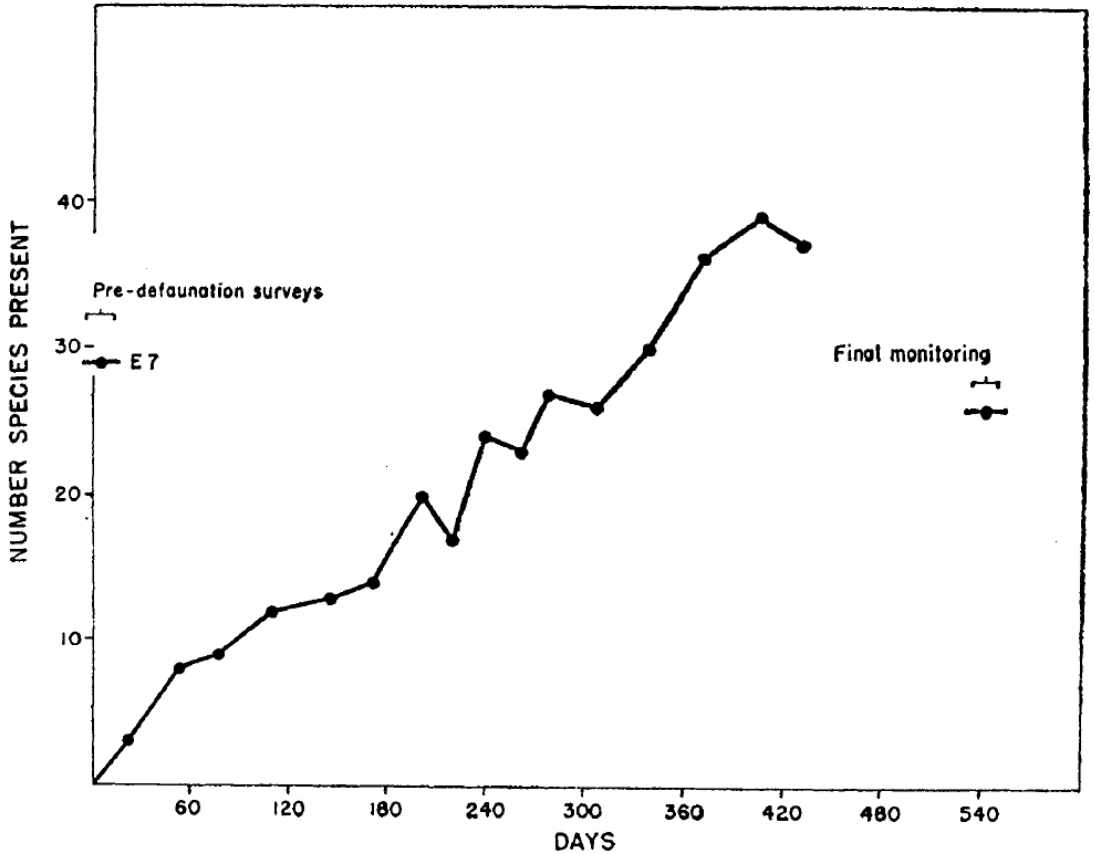

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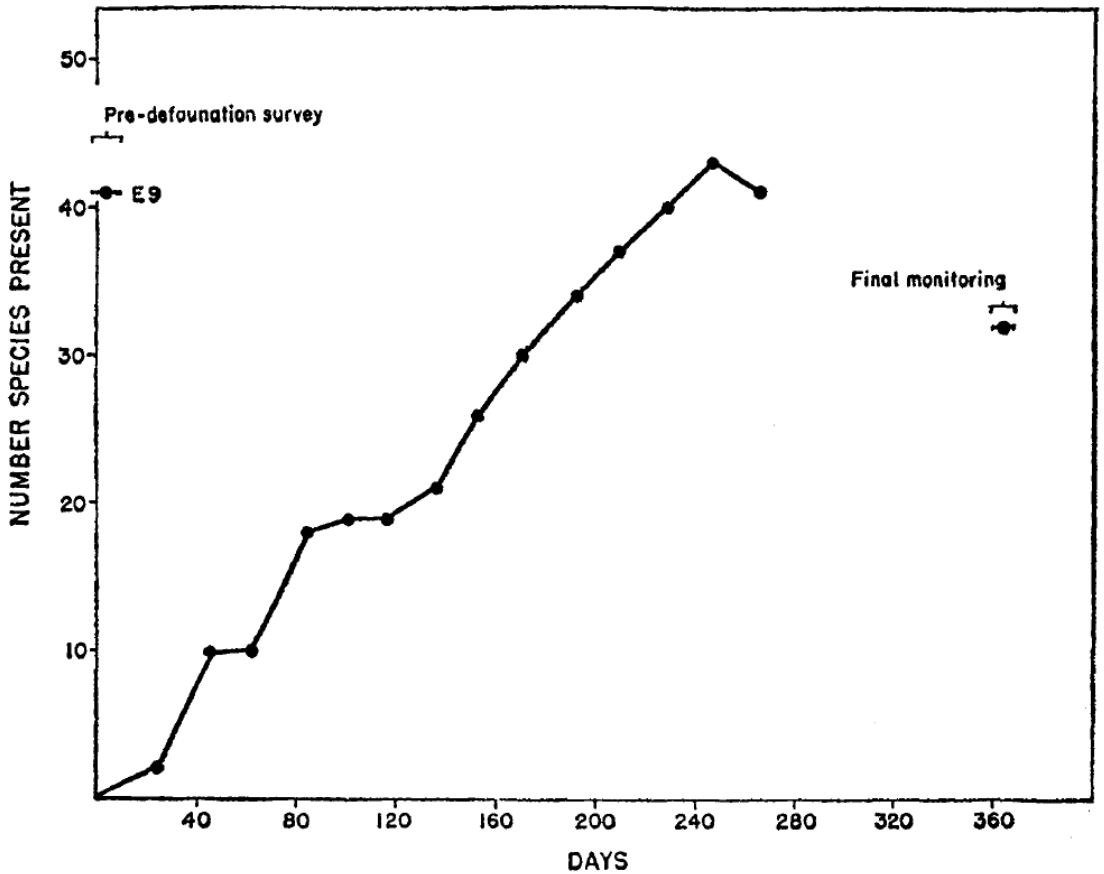

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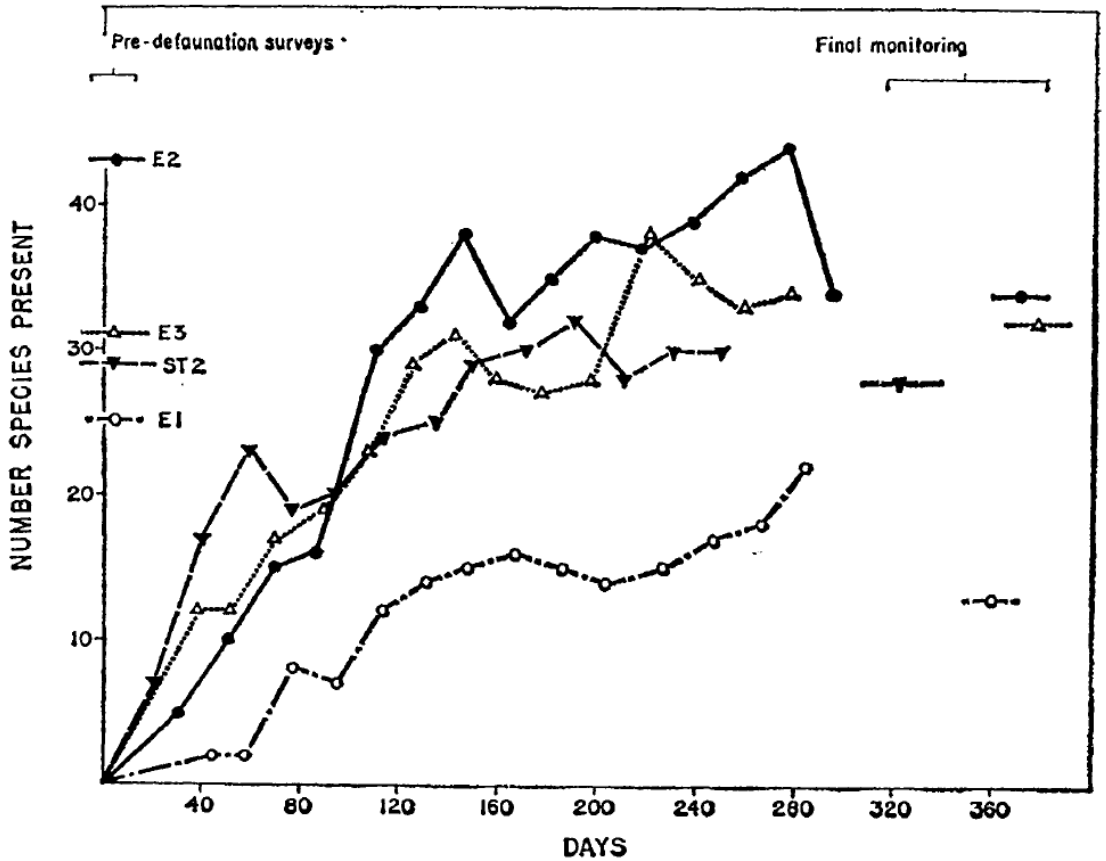

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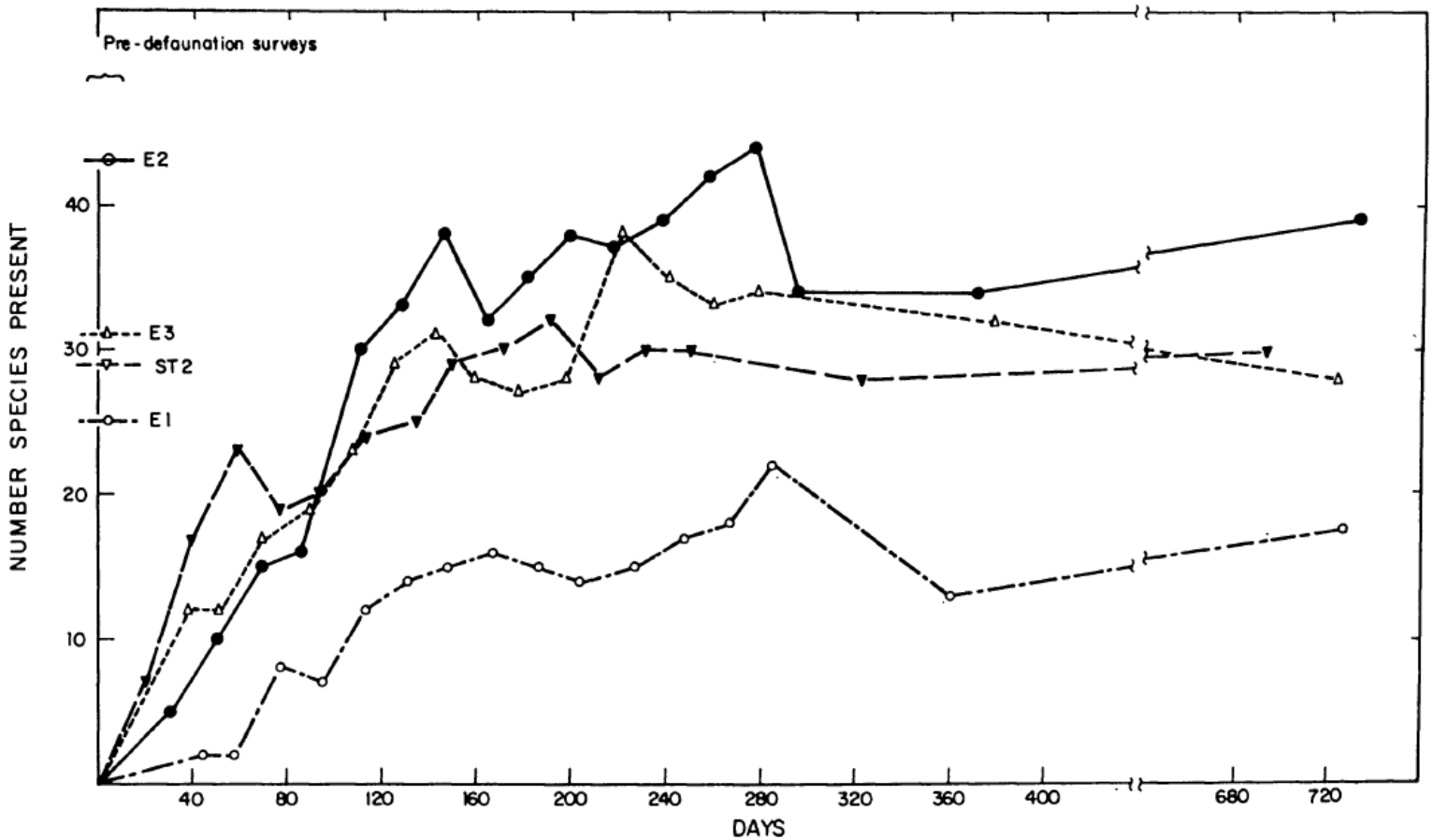

Simberloff & Wilson

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- Results demonstrated a return to an equilibrium state and then a balanced turnover due to offsetting colonization and extinction

- Provided strong support for the theory

- Interestingly, most islands showed a slight overshot of the equilibrium state, then a fall, and then another rise to a new equilibrium point (assortative equilibrium)

Simberloff & Wilson

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- This new equilibrium suggested a convergence toward the original species composition

- There appeared to be some structure in the recolonization process, whereby “more highly co-adapted species sets find themselves by chance on an island and persist longer as sets.”

Simberloff & Wilson

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- While this study provided strong support for the equilibrium hypothesis, it is not without problems and potential complications

- First, the islands were all 11 – 18m in diameter of uniform habitat, and it would be difficult to scale these islands up to larger more complex systems

Simberloff & Wilson

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- In a later paper, Simberloff discussed the problems with measuring turnover of species
- There may have been turnover occurring between surveys, or species being undetected as the come on and back off the island
- Most observed turnover may have been due to ‘transient’ species

Simberloff & Wilson

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- Because turnover is a critical part of the equilibrium model, Simberloff called for rigorous testing of the theory and for experiments to attempt to falsify the model, not simply the attempt to observe it

- Modern studies have called for a reappraisal of the theory, yet it remains a key concept in ecology and biogeography

Simberloff & Wilson

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- One of the main issues with the equilibrium theory is that it treats the dominant ecological processes determining species composition on islands as stochastic and equivalent across species

- The theory does not account for any observed regularities in community organization; the role of competition, predation, and evolution in structuring island communities

- The major focus of contemporary studies in biogeography is the search for those processes, in addition to immigration and extinction, that account for overall community organization

Simberloff & Wilson

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Main Points

- Simberloff and Wilson set out to test the equilibrium theory of island biogeography experimentally
- The found strong support for the theory, but also discovered overshoot and a fall to a new equilibrium point
- There appeared to be some structure in the recolonization process that pointed to species associations
- Modern studies are incorporating the ecological roles of species into the equilibrium model

Questions on the reading?