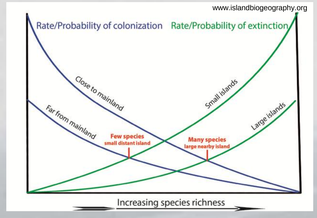
# Island Biogeography at Play on Isle Royale

## The Theory of Island Biogeography and Famous Examples:

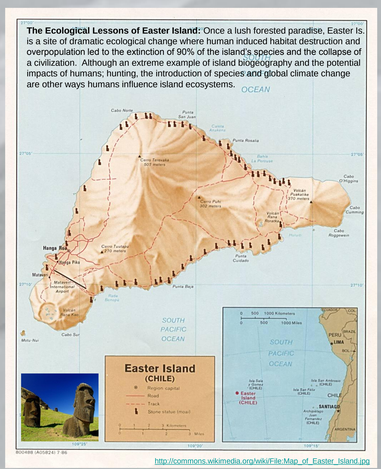
Published in 1967 by Robert H. McCarthur and Edward O. Wilson, a mathematician and myrmecologist (one who studies ants), the theory examines the factors that affect species richness, or number of species represented in an ecological community or localized area. The original factors examined in 1967 included:




1. Immigration vs. Extinction – What species will come and go? Who will persist?

2. Area – Larger islands create more opportunity and influence extinction rates.

3. Distance – How far from the mainland or other islands? How easy is it for species to come and go?




Over time these factors interact to result in an equilibrium level of species richness. A beautifully simple idea that after decades of further scientific inquiry now recognizes the complexity inherent in nature, even simplified isolated systems like islands. Islands are now understood to be any area of suitable habitat in an expanse of unsuitable habitat.

The theory now incorporates non-equilibrial processes and other concepts such as:

4. Target effect – immigration increases as species actively target larger islands

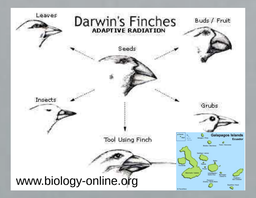
5. Rescue effect – species on less isolated islands are less likely to go extinct because individuals from a source population can immigrate and stay extinction

6. Length of isolation in time

7. Location relative to currents (air and water)

8. Serendipity – literally "happy accident", or chance

9. Human activity

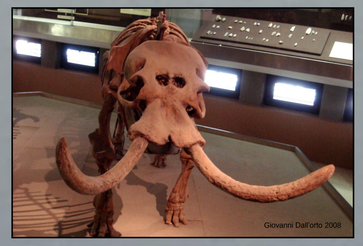



10. Habitat suitability – including climate, initial plant and animal composition, current species composition

11. Nature and frequency of disturbance regimes

12. Geologic processes

13. Speciation and adaptive radiation



**Above:** The Haast's eagle, with a 9 ft. wingspan, and the 11 species of moa, the largest up to 11 ft. tall and weighing 500 lbs., became extinct after the arrival of humans to New Zealand. Both species are examples of insular gigantism. **Left:** The 3 foot tall dwarf elephant of Sicily and Malta, an example of insular dwarfism.

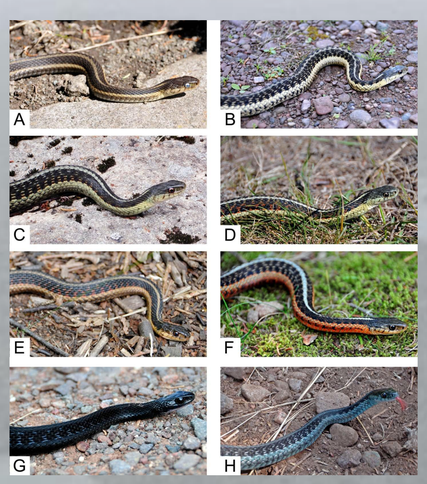
## Examples on Isle Royale …

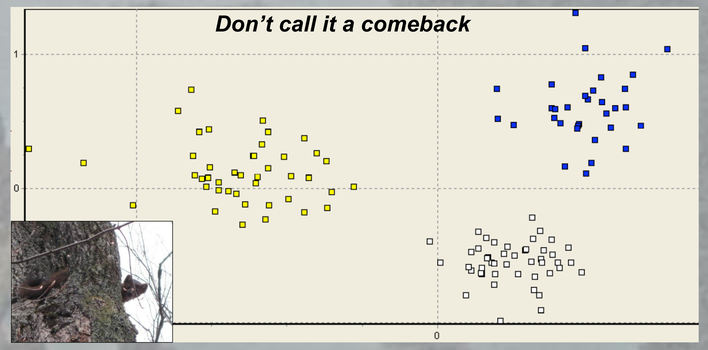
Only fifteen miles from the nearest mainland shoreline, an area totaling over 210 square miles, lacking overt human influences, and surrounded by the cold expanse of Lake Superior, Isle Royale may be an exemplar for the study of island biogeography in northern climates. Resting on a backbone of 1.1 billion year old rock, life on the island is only 10,000 yrs. young in geologic time, and just beginning many of the processes that influence island biogeography following the retreat of the last glaciers.

### *One Species, Many Colors*

64% of the island's eastern garter snake population exhibit color variation. This could be attributable to a founder effect, adaptation or adaptive radiation.

A. Normal
B. Yellow-flecked
C. Red-flecked
D. Red-checkered
E. Red-checkered copper
F. Red
G. Black
H. Blue

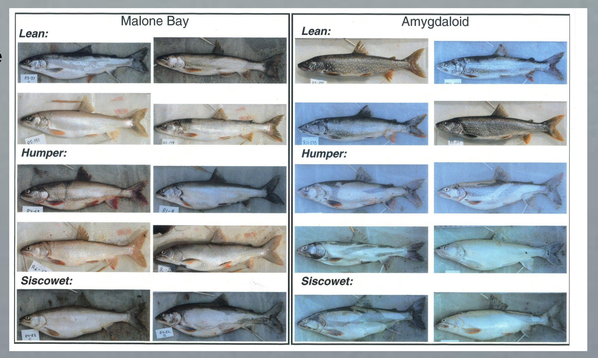



Thought to have been removed by fur trappers around 1920, American marten have returned to the island. However, recent DNA evidence suggest they never left. When compared to populations from northeastern Minnesota (yellow) and Newfoundland (white), it is likely that these populations have been apart from one another for a substantial period of time. As such, marten on Isle Royale warrant protection as a distinct sub-species, similar to Newfoundland's population.

### *Most Diverse Lake Trout Population In the Great Lakes!*

Due to the island's isolation, lake trout around Isle Royale were spared the devastating impacts of commercial fishing and lamprey felt elsewhere in the Great Lakes. Today scientists recognize three phenotypes and 12 morphological variants within those phenotypes.




## Pondering The Implications for Management:

The theory of island biogeography embraces dynamism and uncertainty. It acknowledges that each species is different and each set of circumstances is different. It accepts humans as a part of the ecosystem not separate from it. Any theory that specifically highlights serendipity, " a happy accident", recognizes the inherent complexity of nature as well, natural.

Given all this complexity, uncertainty, and proclivity for change:

- How does one manage island ecosystems and the species they are home to?
- Is one to manage the system and its processes, ignoring individual species?
- What about species who have persisted, and are now genetically and geographically distinct from their mainland counterparts?
- Can one manage both the system and its individual components without too much juxtaposition?
- If island species are on the brink of extirpation, should they be saved? Or is this just the nature of living on an island?
- What if humans were the direct cause of this extirpation? What if humans are the indirect cause, think climate change? What if one is unable to discern the cause of any one particular species path to extirpation? What if there are many causes?
- Does it make a difference if a species is native or non-native? What if a non-native species was by all accounts serving as a valuable and needed component of that ecosystem?

### *Insular Gigantism?*

Large toads are common place on Islands, but could the American toads on Isle Royale be migrating slowly towards gigantism? Lack of predation and bountiful resources likely allow these toads to grow old and large, and may be paving the way for speciation to create a giant.

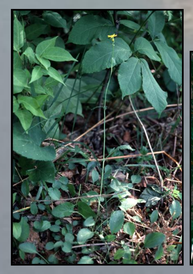
### *Islands Within An Island*

Inland lakes at Isle Royale offer differing species compositions over time. Notably, cold water species like brook trout and cisco (circled red below) have disappeared from lakes where warming waters, likely attributable to climate change, have made habitat unsuitable. Research efforts between 2011-2013, suggest cisco populations are greatly diminished or extirpated from Lake Richie, Sargent Lake and Lake Desor.

**Table 3.** Comparison of the distribution of fish in inland lakes in Isle Royale National Park, Michigan in 1995–1997 to distributions reported by Hubbs and Lagler (1949). NC = present in both time periods; KA = present only in 1995–1997; and, HL = reported only by Hubbs and Lagler (1949). Dashes indicate fish was not present in that lake.

| | Lakes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | AHM | AMY | ANG | BEA | BEN | CHI | DES | DUS | EPI | EVA | FEL | FOR | GEO | HAL | HAR | HAT | INT | JOH | LES | LIN | LIV | MAS | MCD | OTT | PAT | RIC | SAR | SCH | SHE | SIS | WAG | WHI |
| Cisco | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | NC | -- | -- | NC | -- | -- |
| Lake whitefish | -- | -- | -- | -- | -- | | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- |
| Brook trout | -- | -- | -- | -- | -- | | HL | -- | -- | -- | -- | -- | -- | -- | -- | HL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lake trout | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- |
| Northern pike | NC | NC | NC | NC | -- | NC | -- | NC | NC | NC | NC | -- | NC | NC | -- | -- | NC | HL | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| Lake chub | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Pearl dace | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | NC | -- | -- | NC | NC | -- | KA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Golden shiner | -- | -- | -- | NC | -- | -- | -- | -- | NC | -- | -- | -- | NC | -- | -- | NC | -- | -- | NC | -- | NC | -- | HL | -- | NC | NC | -- | NC | -- | -- | -- | -- |
| Emerald shiner | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- |
| Blackchin shiner | -- | -- | -- | -- | -- | KA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | KA | -- | -- | -- | -- | -- |
| Blacknose shiner | -- | -- | -- | NC | NC | KA | -- | NC | -- | NC | -- | NC | -- | NC | NC | -- | NC | NC | -- | NC | NC | NC | -- | NC | -- | NC | NC | NC | NC | NC | -- | KA |
| Spottail shiner | -- | NC | -- | HL | -- | NC | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | NC | -- | NC | NC | -- | -- | NC | -- | NC |
| Mimic shiner | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- |
| N. redbelly dace | -- | -- | -- | -- | -- | KA | KA | -- | -- | -- | -- | -- | -- | -- | -- | KA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Finescale dace | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | KA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Fathead minnow | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | NC | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Creek chub | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| White sucker | -- | -- | KA | -- | -- | NC | NC | NC | -- | -- | NC | -- | -- | -- | NC | NC | NC | NC | -- | -- | -- | -- | -- | -- | -- | NC | NC | HL | -- | NC | -- | NC |
| Trout-perch | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | NC | HL | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | NC | -- | NC |
| Burbot | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- |
| Brook stickleback | -- | -- | -- | -- | KA | -- | NC | -- | -- | -- | -- | -- | -- | -- | NC | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | KA | -- | -- | -- | HL | -- | -- |
| Ninespine stickleback | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | HL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- |
| Pumpkinseed | -- | -- | -- | -- | -- | KA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | NC | KA | -- | -- | -- | -- | -- |
| Iowa darter | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- |
| Yellow perch | NC | NC | NC | NC | NC | NC | -- | NC | NC | KA | NC | NC | NC | NC | NC | -- | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | KA | NC |
| Logperch | -- | -- | -- | -- | -- | -- | -- | HL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | NC |
| Walleye | -- | -- | -- | -- | -- | NC | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC |
| Mottled sculpin | -- | -- | -- | -- | -- | HL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Slimy sculpin | -- | -- | -- | -- | -- | HL | HL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | HL | -- | -- | -- | NC | NC | -- | -- | NC | -- | -- |
| Spoonhead sculpin | -- | -- | -- | -- | -- | -- | NC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NC | -- | HL |

### *Found Exclusively on Isle Royale!!!*



In an area no larger than the size of your living room lives a small population of Isle Royale's only endemic Species, the Isle Royale ragwort (*Packera insulae-regalis*).