Limiting factor

A **limiting factor** is a variable of a system that causes a noticeable change in output or another measure of a type of system. The limiting factor is in a pyramid shape of organisms going up from the producers to consumers and so on. A factor not limiting over a certain domain of starting conditions may yet be limiting over another domain of starting conditions, including that of the factor.

Contents

Overview

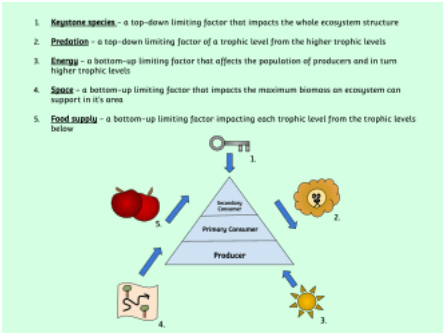
The identification of a factor as limiting is possible only in distinction to one or more other factors that are non-limiting. Disciplines differ in their use of the term as to whether they allow the simultaneous existence of more than one limiting factor which (may then be called "co-limiting"), but they all require the existence of at least one non-limiting factor when the terms are used. There are several different possible scenarios of limitation when more than one factor is present. The first scenario, called *single limitation* occurs when only one factor, the one with maximum demand, limits the System. *Serial co-limitation* is when one factor has no direct limiting effects on the system, but must be present to increase the limitation of a second factor. A third scenario, *independent limitation,* occurs when two factors both have limiting effects on the system but work through different mechanisms. Another scenario, *synergistic limitation,* occurs when both factors contribute to the same limitation mechanism, but in different ways.[1]

In 1905 Frederick Blackman articulated the role of limiting factors as follows: "When a process is conditioned as to its rapidity by several separate factors the rate of the process is limited by the pace of the slowest factor." In terms of the magnitude of a function, he wrote, "When the magnitude of a function is limited by one of a set of possible factors, increase of that factor, and of that one alone, will be found to bring about an increase of the magnitude of the function."[2]

Ecology

In population ecology, a **regulating factor**, also known as a *limiting factor*,[3] is something that keeps a population at equilibrium (neither increasing nor decreasing in size over time). Common limiting factor resources are environmental features that limit the growth, abundance, or distribution of an organism or a population of organisms in an ecosystem.[4]:G-11[5] The concept of limiting factors is based on *Liebig's Law of the Minimum,* which states that growth is controlled not by the total amount of resources available, but by the scarcest resource. In other words, a factor is limiting if a change in the factor produces increased growth, abundance, or distribution of an organism when

other factors necessary to the organism's life do not. Limiting factors may be physical or biological.[4]:417,8



Limiting factors in ecology figure

Limiting factors are not limited to the condition of the species. Some factors may be increased or reduced based on circumstances. An example of a limiting factor is sunlight in the rain forest, where growth is limited to all plants on the forest floor unless more light becomes available. This decreases the number of potential factors that could influence a biological process, but only one is in effect at any one place and time. This recognition that there is always a *single* limiting factor is vital in ecology, and the concept has parallels in numerous other processes. The limiting factor also causes competition between individuals of a species population. For example, space is a limiting factor. Many predators and prey need a certain amount of space for survival: food, water, and other biological needs. If the population of a species is too high, they start competing for those needs. Thus the limiting factors hold down population in an area by causing some individuals to seek better prospects elsewhere and others to stay and starve. Some other limiting factors in biology include temperature and other weather related factors. Species can also be limited by the availability of macro- and micronutrients. There has even been evidence of co-limitation in prairie ecosystems. A study published in 2017 showed that sodium (a micronutrient) had no effect on its own, but when in combination with nitrogen and phosphorus (macronutrients), it did show positive effects, which is evidence of serial co-limitation.[1]

Business and technology

AllBusiness.com defines a limiting (constraining) factor as an "item that restricts or limits production or sale of a given product". The examples provided include: "limited machine hours and labor-hours and shortage of materials and skilled labor. Other limiting factors may be cubic feet of display or warehouse space, or working capital."[6] The term is also frequently used in technology literature.[7][8]

The analysis of limiting business factors is part of the program evaluation and review technique, critical path analysis, and theory of constraints as presented in the novel *The Goal*.

Chemistry

In stoichiometry of a chemical reaction to produce a chemical product, it may be observed or predicted that with amounts supplied in specified proportions, one of the reactants will be consumed by the reaction before the others. The amount of product is thus limited by the supply of this reagent. This limiting reagent determines the theoretical yield of the reaction. The other reactants are said to be non-limiting or in excess. This distinction makes sense only when the equilibrium so favors the products to cause the complete consumption of one of the reactants.

In studies of reaction kinetics, the rate of progress of the reaction may be limited by the concentration of one of the reactants or catalysts. In multi-step reactions, a step may be rate-limiting in terms of production of the final product. In vivo in an organism or an ecologic system, such factors as those may be rate-limiting, or in the overall analysis of a multi-step process including biologic, geologic, hydrologic, or atmospheric transport and chemical reactions, transport of a reactant may be limiting.

See also

- Abiotic component
- Bateman's principle

- Biotic component
- Competition (biology)
- Competitive exclusion principle
- Ecology
- Population ecology
- Resource (biology)
- Shelter

References

1. Kaspari, Michael; Roeder, Karl A.; Benson, Brittany; Weiser, Michael D.; Sanders, Nathan J. (2017-02-01). "Sodium co-limits and catalyzes macronutrients in a prairie food web" (https://doi.org/10.1002%2Fecy.1677). *Ecology*. **98** (2): 315–320. doi:10.1002/ecy.1677 (https://doi.org/10.1002%2Fecy.1677). ISSN 1939-9170 (https://www.worldcat.org/issn/1939-9170). PMID 27936500 (https://pubmed.ncbi.nlm.nih.gov/27936500).
2. F.F. Blackman (1905) "Optima and Limiting Factors", Annals of Botany, doi:10.1093/oxfordjournals.aob.a089000 (https://doi.org/10.1093%2Foxfordjournals.aob.a089000)
3. Francois Messier (June 1991). "The Significance of Limiting and Regulating Factors on the Demography of Moose and White-Tailed Deer". *The Journal of Animal Ecology*. **60** (2): 377–393. doi:10.2307/5285 (https://doi.org/10.2307%2F5285). JSTOR 5285 (https://www.jstor.org/stable/5285).
4. Thomas M. Smith., Robert Leo Smith. 2009. Or simply, Limiting factors are things that prevent a population from growing any large. *Elements of Ecology*. Pearson International Edition. 7th Ed.
5. "Limiting factor - Biology-Online Dictionary" (http://www.biology-online.org/dictionary/Limiting_factor).
6. "Business definition for: Limiting (constraining) factor" (https://www.allbusiness.com/glossaries/constraining-limiting-factor/4949815-1.html). *AllBusiness Business Glossary*. Retrieved April 28, 2013.
7. Sheriff, A., Bouchlaghem, D., El-Hamalawi, A., and Yeomans, S. (2012). "Information Management in UK-Based Architecture and Engineering Organizations: Drivers, Constraining Factors, and Barriers". *Journal of Management in Engineering*. **28** (2). pp. 170–180.
8. John Leslie King, Vijay Gurbaxani, Kenneth L. Kraemer, F. Warren McFarlan, K. S. Raman & C. S. Yap (June 1994). "Institutional Factors in Information Technology Innovation" (http://isr.journal.informs.org/content/5/2/139.abstract). *Information Systems Research*. **5** (2). pp. 139–169. doi:10.1287/isre.5.2.139 (https://doi.org/10.1287%2Fisre.5.2.139).

Further reading

- Raghothama, K. G. & Karthikeyan, A.S. (2005) "Phosphate acquisition", Plant and Soil 274: 37-49.
- Taylor, W. A. (1934) "Significance of extreme or intermittent conditions in distribution of species and management of natural resources, with a restatement of Liebig's Law of the minimum", Ecology 15: 374-379.
- Shelford, V. E. (1952). Paired factors and master factors in environmental relations. *Illinois Acad. Sci. Trans.*, 45: 155-160
- Sundareshwar P.V., J.T. Morris, E.K. Koepfler, and B. Fornwalt (2003) "Phosphorus limitation of coastal ecosystem processes", Science 299:563-565.