Model Selection in Ecology and Evolution

JB Johnson & KS Omland 2004

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Alternative Paradigm

Dominant paradigm

- Null hypothesis testing
- Arbitrary threshold ($p < 0.05$)
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Alternative paradigm

- Model selection (Information-theoretic)
- Multiple competing hypotheses (quantitative evidence for each)

Advantages

Not restricted to single model

Ability to rank and weigh models

Model averaging (MMI)

Hypotheses to Models

1) Articulate competing hypotheses
2) Specify variables (causal factors)
3) Decide the functions that relate independent variables and response variable
4) Define error structure

Iterative process

< 20 Models

When to use Model Selection?

Experimental manipulation not possible

Observational data

Complex systems

Historical scenarios

Use of Model selection

Table 1. Increasing use of model selection in ecology and evolution

Discipline	Problem
Ecology	
Natural history	Identifying foraging strategies of species (generalist versus specialist)
Population ecology and management	Isolating endogenous and exogenous mechanisms of regulation
	Detecting spatial heterogeneity in population regulation
	Relating survival rates to physiological and environmental factors (mark–recapture data
	Correlating vital rates with covariates (monitoring data)
	Modeling herbivore functional response
Behavioral ecology	Discerning how animals allocate risk in response to predation
	Modeling dispersal
Community ecology	Modeling effects of fire on community organization
Landscape ecology	Predicting how vertebrate populations respond to habitat loss and fragmentation
Ecosystem science	Deciphering trophic relationships
Evolution	
Molecular evolution	Understanding the process of nucleotide/protein evolution
Molecular systematics	Choosing a model of molecular evolution for phylogenetic reconstruction
Life history evolution	Identifying selective agents associated with phenotypes
Adaptive radiation	Estimating historical diversification rates of lineages
Genetic mapping	Identifying the genetic architecture of phenotypes
Population genetics	Examining patterns of gene flow
Historical demography	Using genetic markers to infer past population dynamics

Potential pitfalls

Set of candidate models

Predictions and parameter estimates must be biologically plausible

Appropriate use

Further reading

Papers

JB Johnson & KS Omland 2004 Model Selection in Ecology and Evolution, Trends in Ecology and Evolution 19(2):101-8

Anderson, D. R., K. P. Burnham, et al. (2000). "Null hypothesis testing: problems, prevalence and an alternative." Journal of Wildlife Management **64**: 912-923.

Stephens, P. A., S. W. Buskirk, et al. (2007). "Inference in ecology and evolution." Trends in Ecology & Evolution **22**(4): 192-197.

Books

Burnham, K. P. and D. R. Anderson (2002). Model Selection and Multi-Model Inference: a Practical Information Theoretic Approach. New York, USA, Springer-Verlag.

Hilborn, R. and M. Mangel (1997). The Ecological Detective: Confronting Models with Data. Princeton, New Jersey, USA, Princeton University Press.