Modelling ecological absence-presence data along an environmental gradient: threshold levels of the environment

Christian Damgaard
Department of Terrestrial Ecology
NERI, Denmark

Absence-presence data along an environmental gradient

Often ecological data is collected as absence-presence data at a specific site.

If the sites are distributed along an environmental gradient, the data may be used to generate hypotheses of community dynamic processes.

Modelling the probability of being present as a function of an environmental gradient.

- niche widths
- shape of the species response
- applied ecology: threshold levels

Modelling approach

- Model selection among three complementary models using the Bayesian Information Criterion (BIC)
  - independence, monotonic or optimum
  - the assumption of complementarity assures relevance of the BIC
- Estimating possible threshold levels of the environment
  - Bayesian posterior distribution
  - Metropolis - Hastings algorithm

Modified sigmoid function

$$f(x;a,d,b,x_0) = \frac{(a-d)+\exp(-b\,x_0)}{1+\exp\left(b\,(x-x_0)\right)}+d$$

f **(*x*) is the probability of occurrence as a function of the environment**

$x \geq 0$; $a \in [0, 1]$, $d \in [0, 1]$, $b \in [0, \infty]$

x_0 **is the threshold level of the environment**

the range of *f* (*x*) is [0, 1]

Model selection

Using the modified sigmoid function the three complementary models were described.

- independence - $f(x) = c$
- monotonic - increasing or decreasing
- optimum - $f_{increasing}(x) * f_{decreasing}(x)$

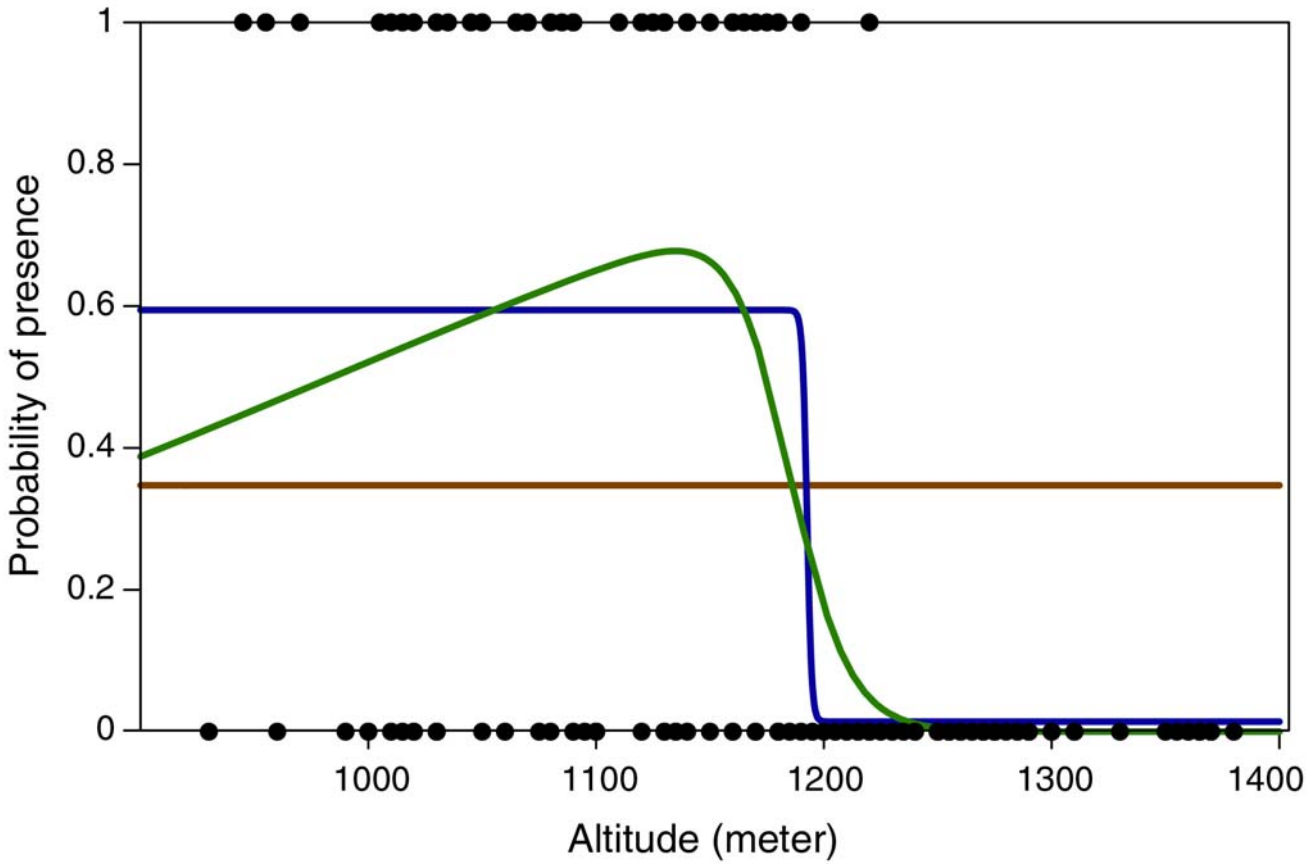
BIC - number of free parameters?

- actual number of parameters
- subjective assessment based on the sampled covariance
- deviance of the MCMC sample (Spiegelhalter et al., 2002)

Bauera rubioides along an elevation gradient

(Oksanen & Minchin, 2002)

independence **monotonic** **optimum**

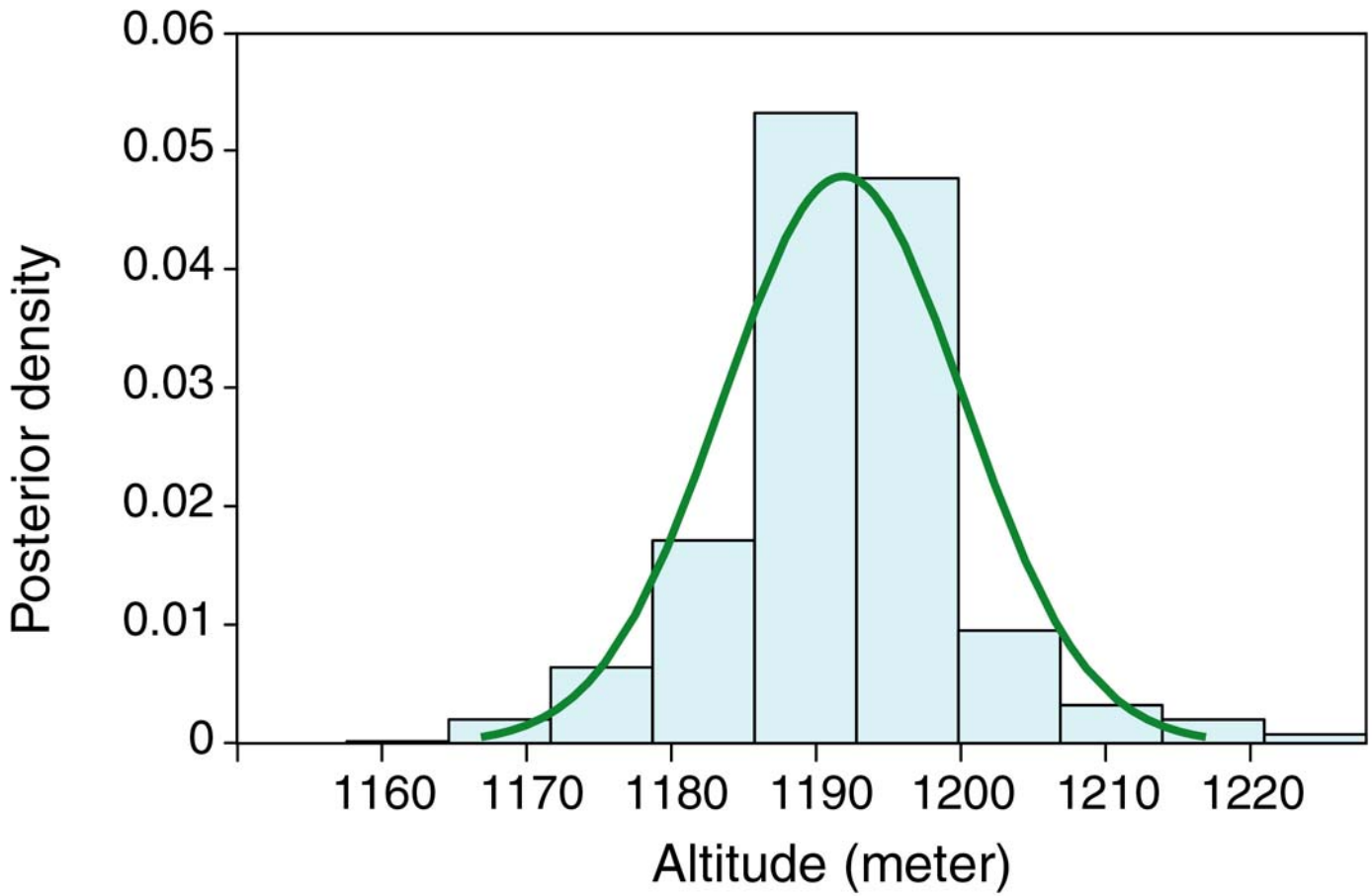


Model selection - *Bauera rubioides*

	Independence		Monotonic		Optimum	
Maximum log-likelihood value	-107.842		-70.197		-68.759	
	p_1	P(*M1*)	p_2	P(*M2*)	p_3	P(*M3*)
without adjustment of p_i	1	<0.0001	5	0.97	7	0.03
adjustment of p_i using observations on the covariance	1	<0.0001	ca. 4	0.75	ca. 5	0.25
adjustment of p_i using the deviance of the MCMC sample	0.96	<0.0001	3.2	0.24	3.3	0.76

Threshold of *Bauera rubioides*

(Oksanen & Minchin, 2002)



Conclusions

- Model selection depends critically on the assumed number of free parameters
- Posterior distributions of environmental threshold levels may be obtained
- Knowledge on threshold levels may be useful in applied ecological cases
  - management of natural habitats