基于条件概率测度树种生态位宽度和重叠：以西双版纳和哀牢山样地为例

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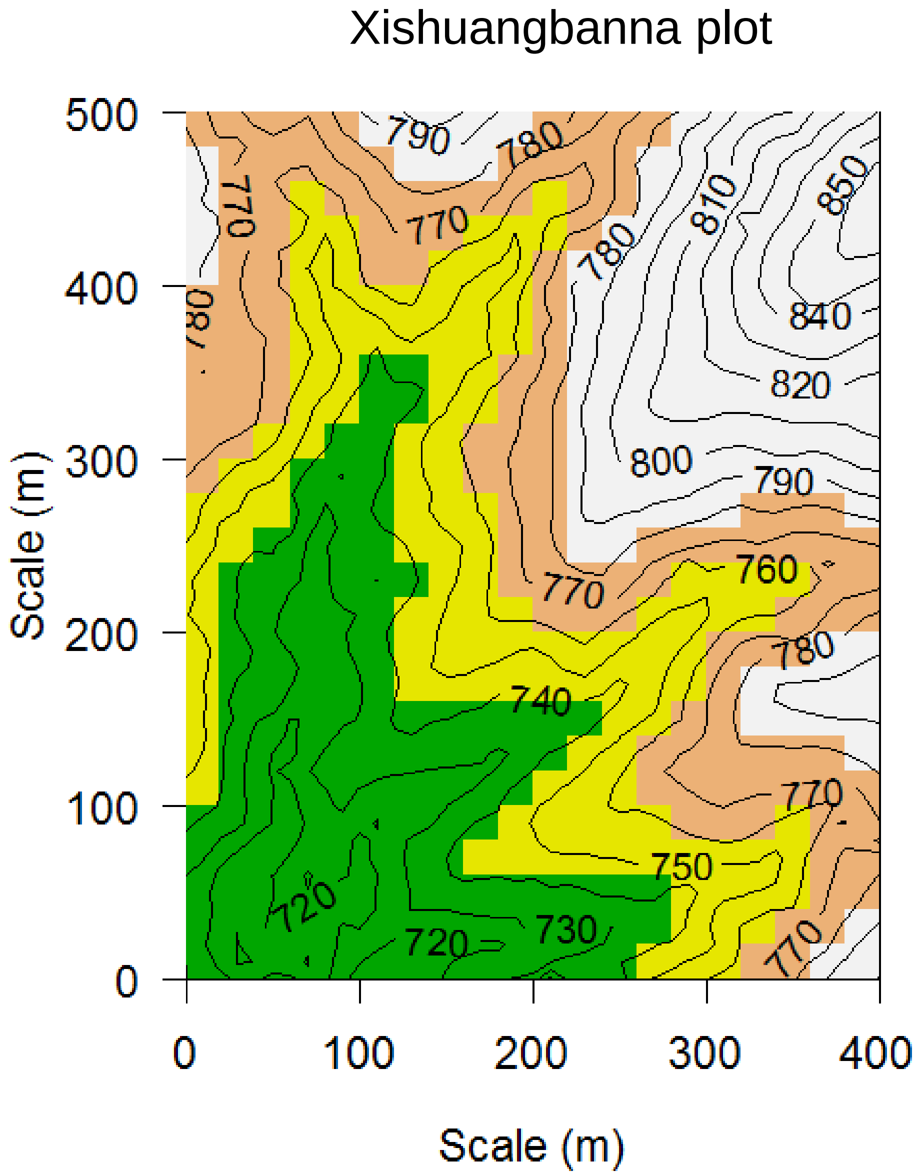
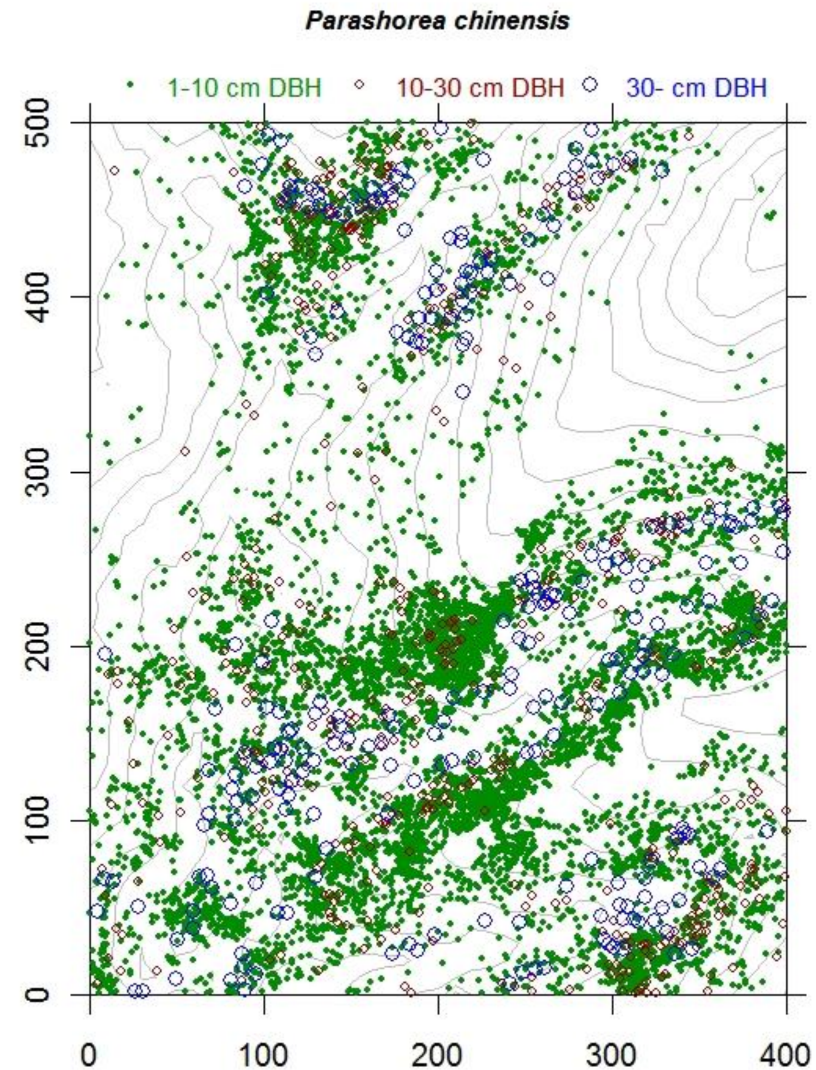
- 条件概率

$$p(E \mid x) = \frac{p(x \mid E)\, p(E)}{p(x)}$$

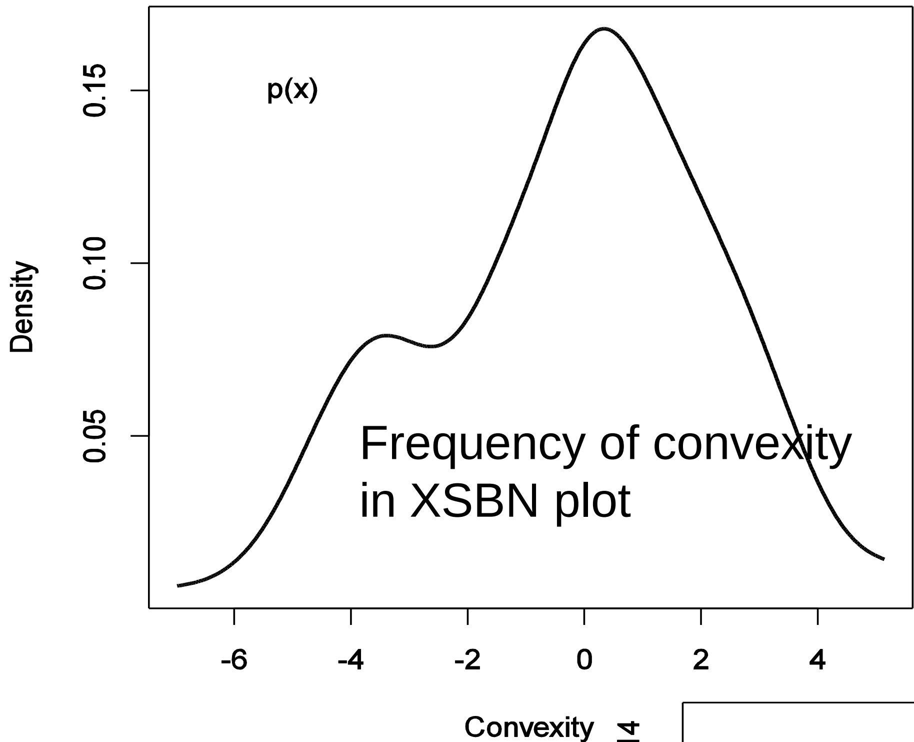
- 给定生境变量的取值x，目标树种出现的条件概率 $p(E|x)$
- $p(E|x)$不受样地内生境变量取值分布的影响

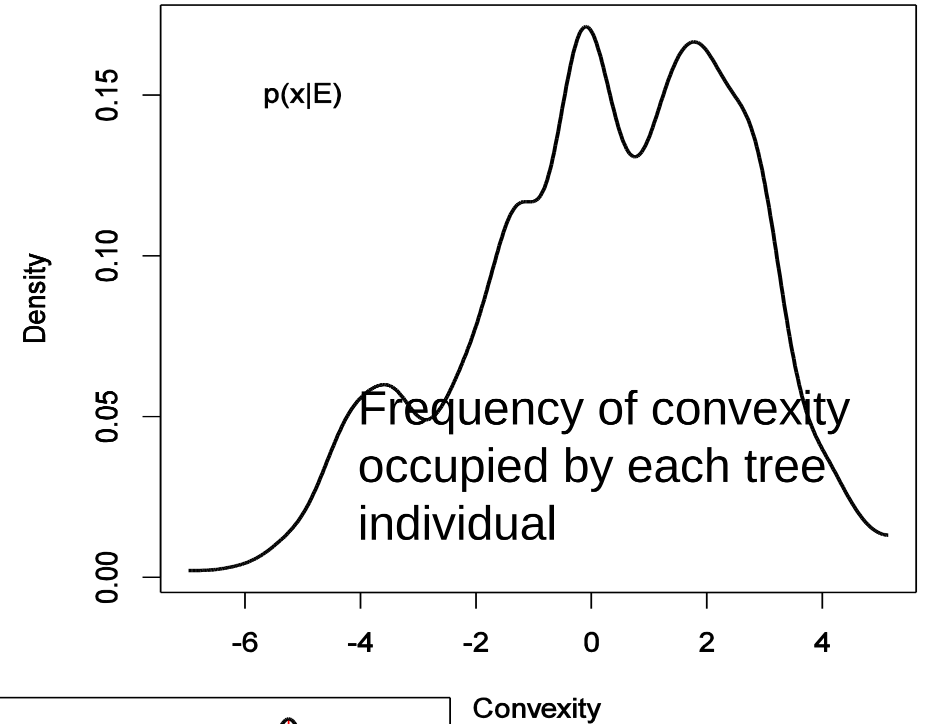


Continuous elevation (from 713 m to 862 m)

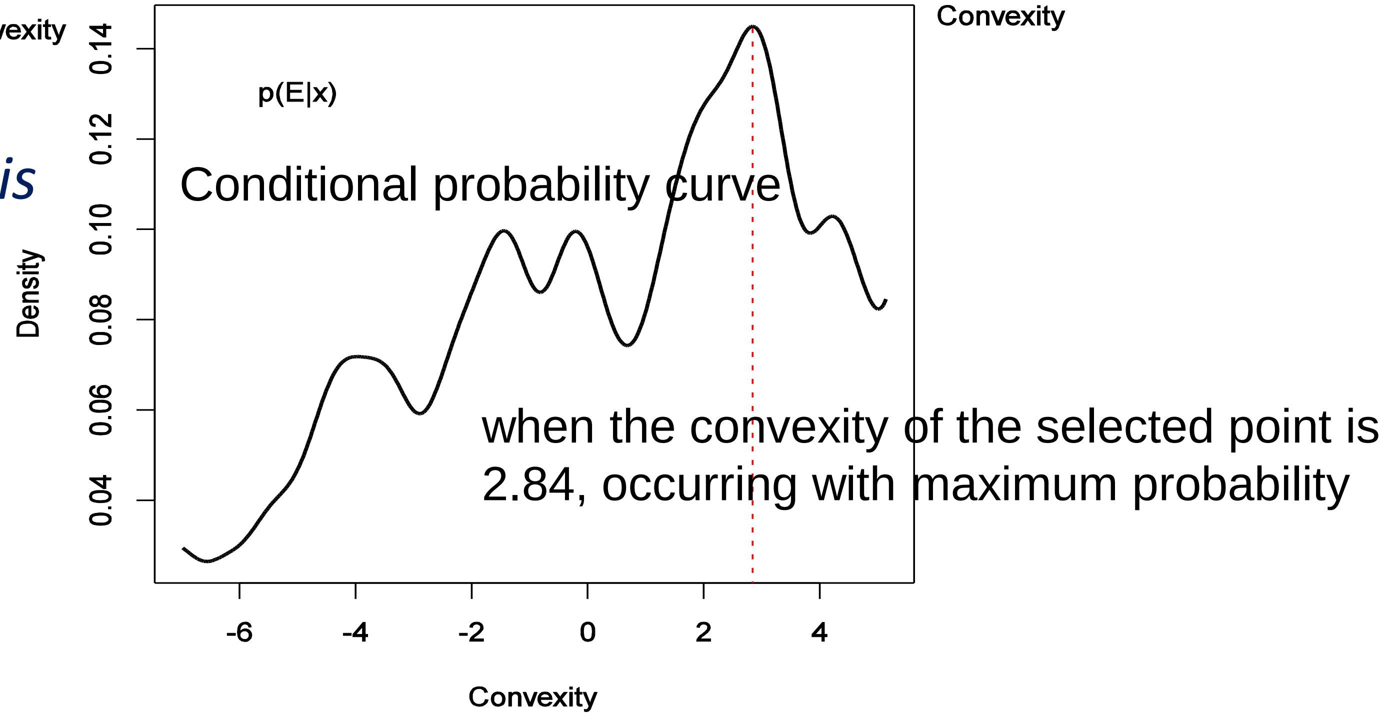


Population distribution of *Parashorea chinensis*





Parashorea chinensis

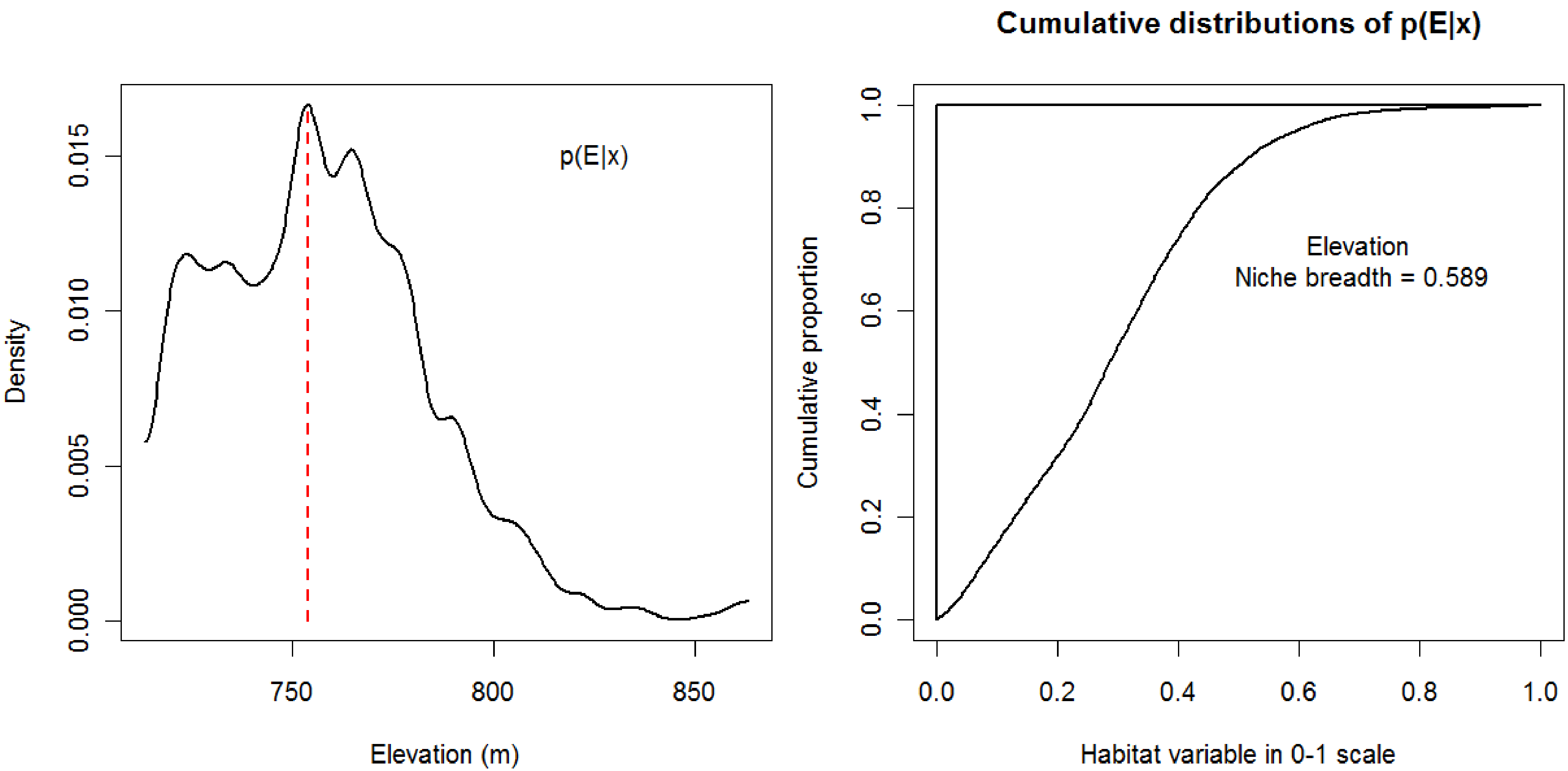


生态位宽度

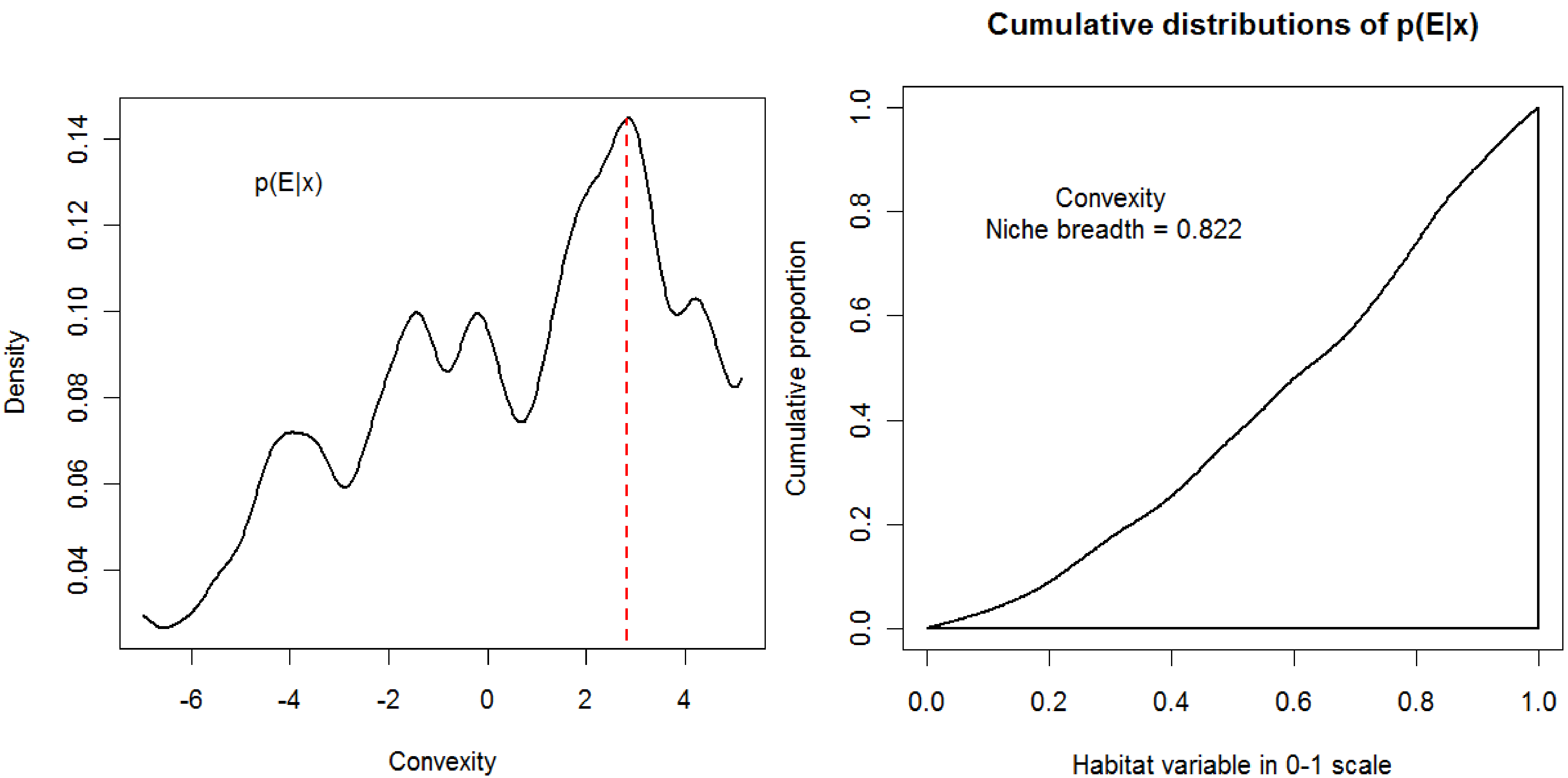
从 $p(E|x)$ to 生态位宽度

- 目标树种A，其每个个体占据的生境变量的取值
- Step 1: 计算$p_A(E|x)$的累积分布
- Step 2: 计算累积分布曲线与生境变量轴（scaled to 0-1）或者累积比例轴（ranging from 0 to 1）之间的面积
- Step 3: 较小面积的2倍值即为生态位宽度（ranging between 0 and 1）

Parashorea chinensis



Parashorea chinensis

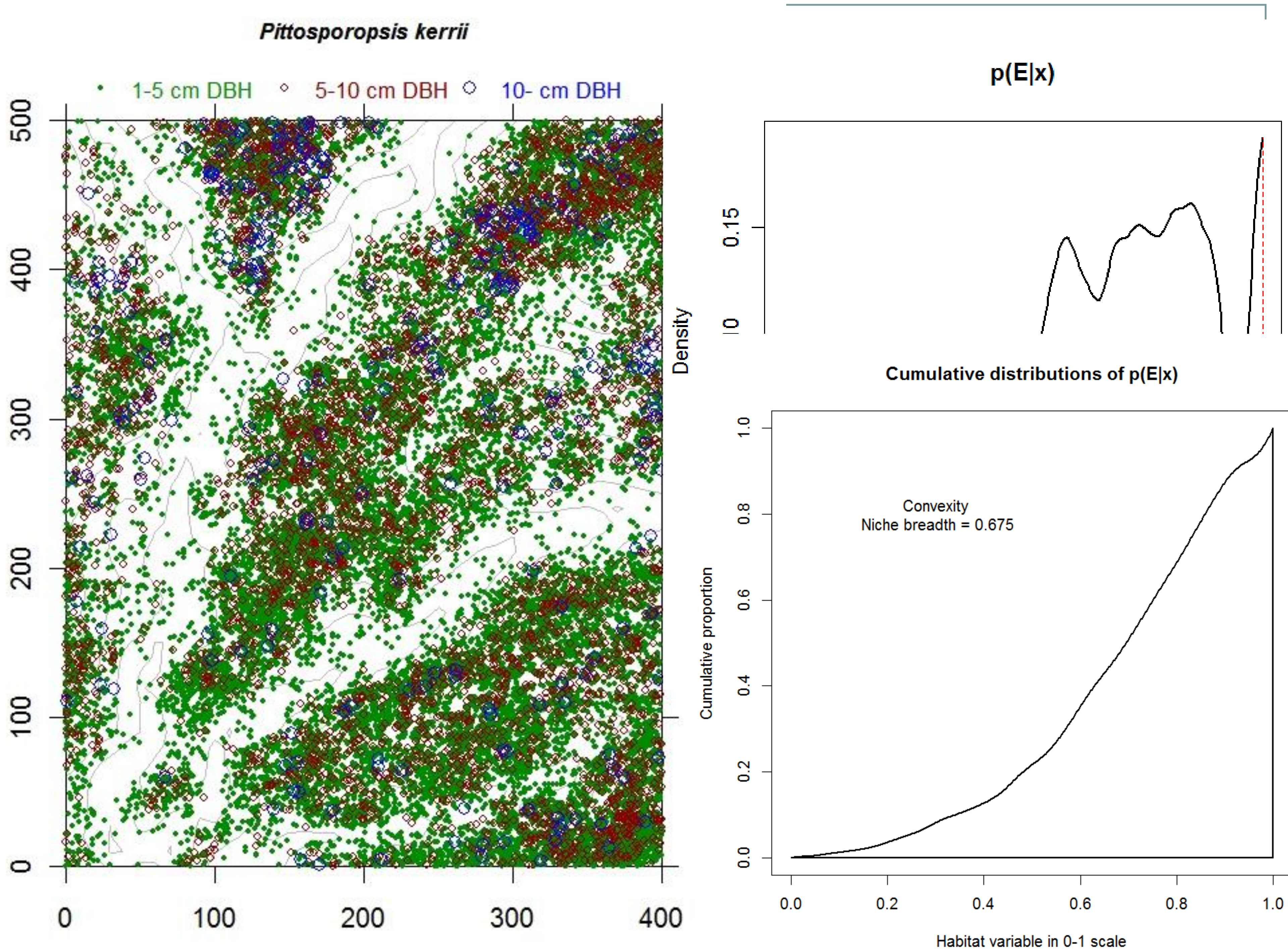


- ✓假如目标树种A没有出现在生境变量的取值范围内，累积分布曲线将与生境变量轴重叠，此时生态位宽度的值为0
- ✓假如目标树种A在生境变量取值范围内具有均匀的出现概率，累积分布曲线将与45°线重叠，此时生态位宽度的值为1

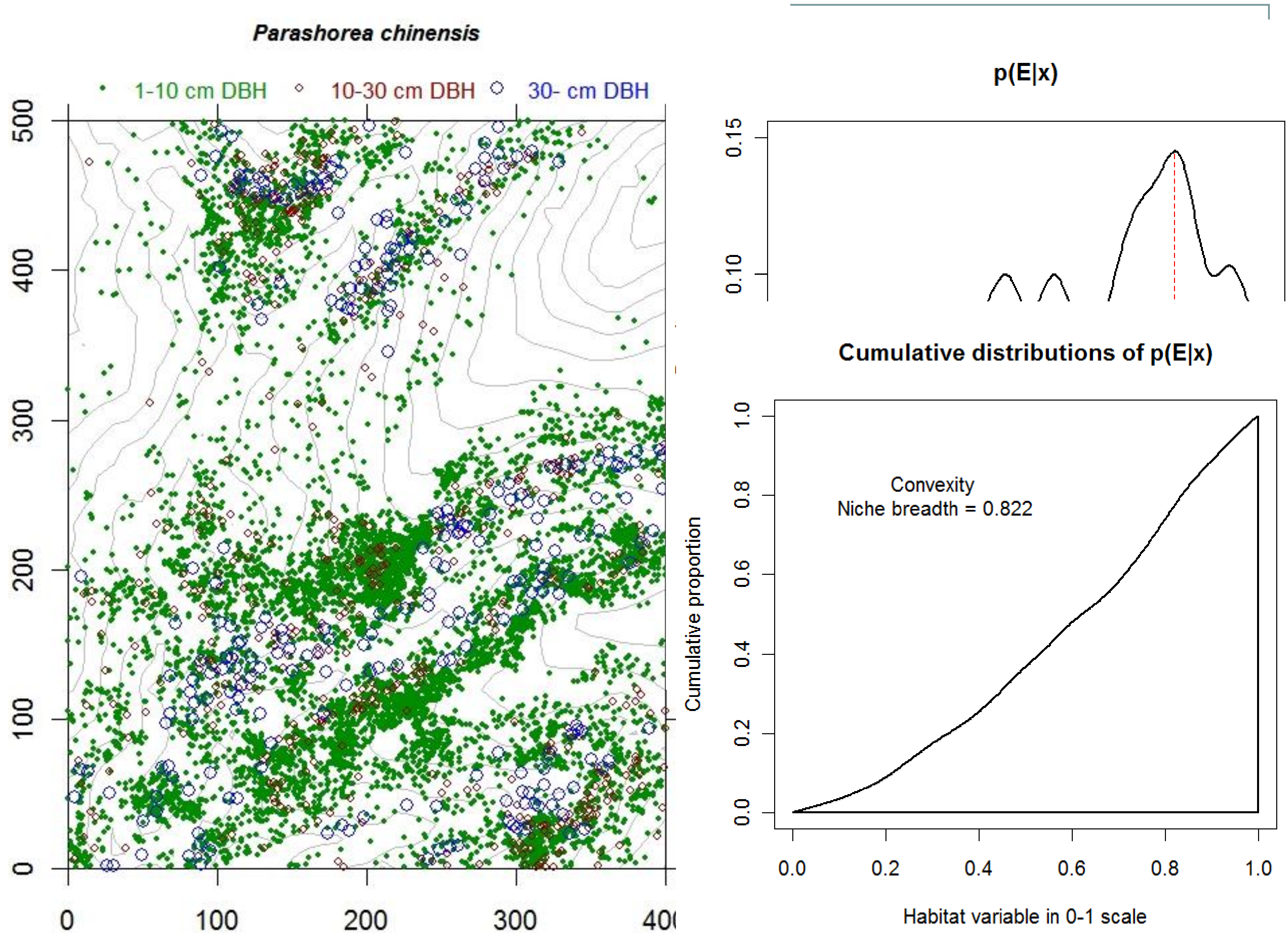
生态位重叠

从 $p(E|x)$ to 生态位重叠

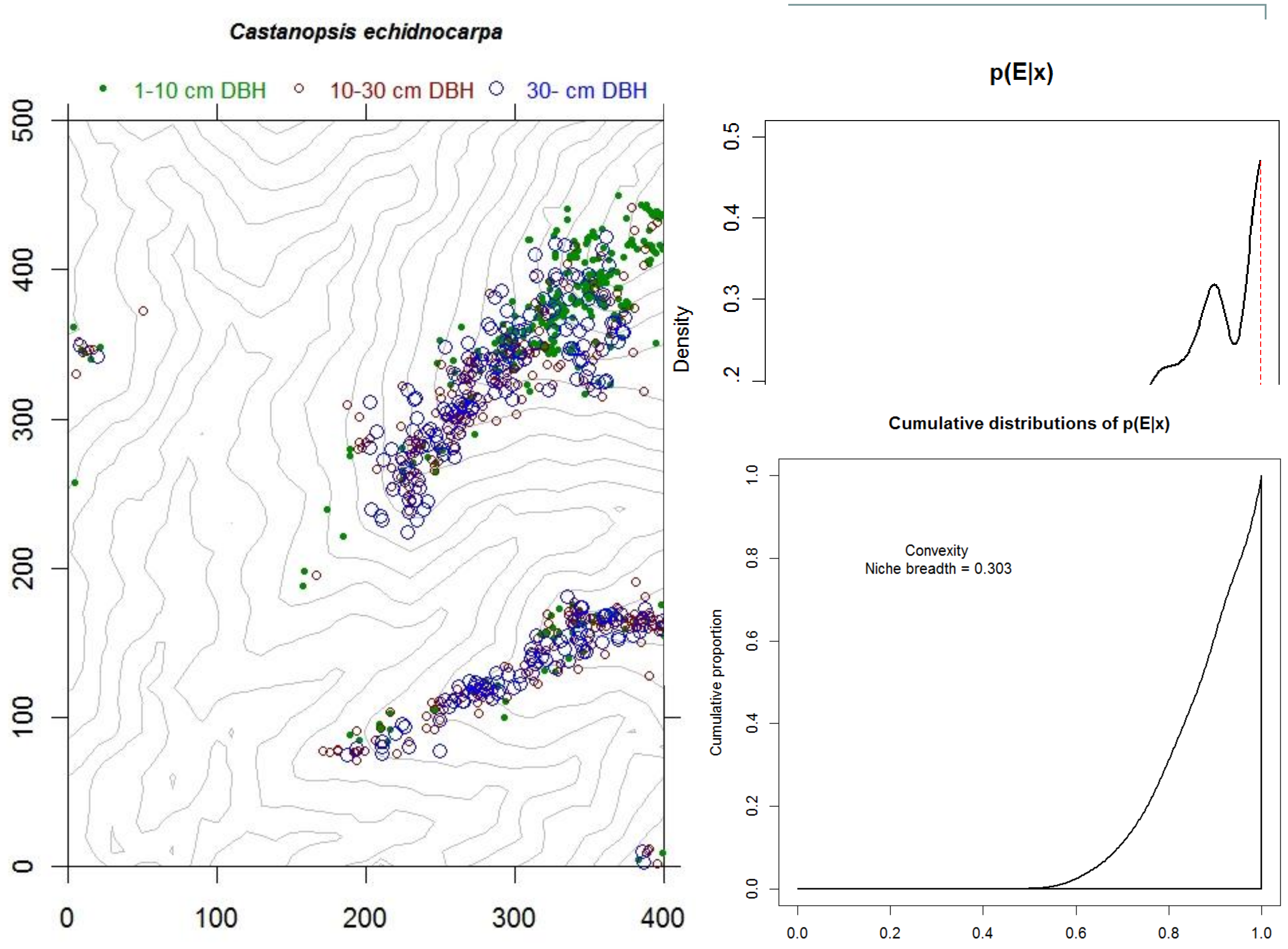
- 目标树种A和B，其每个个体占据的生境变量的取值x
- **Step 1**: 计算$p_A(E|x)$和$p_B(E|x)$的累积分布$P_A(E|x)$和$P_B(E|x)$
- **Step 2**: 计算点对（$P_A(E|x)$, $P_B(E|x)$）的曲线与$P_A(E|x)$轴或者$P_B(E|x)$轴之间的面积
- **Step 3**: 较小面积的2倍值即为生态位重叠（ranging between 0 and 1）



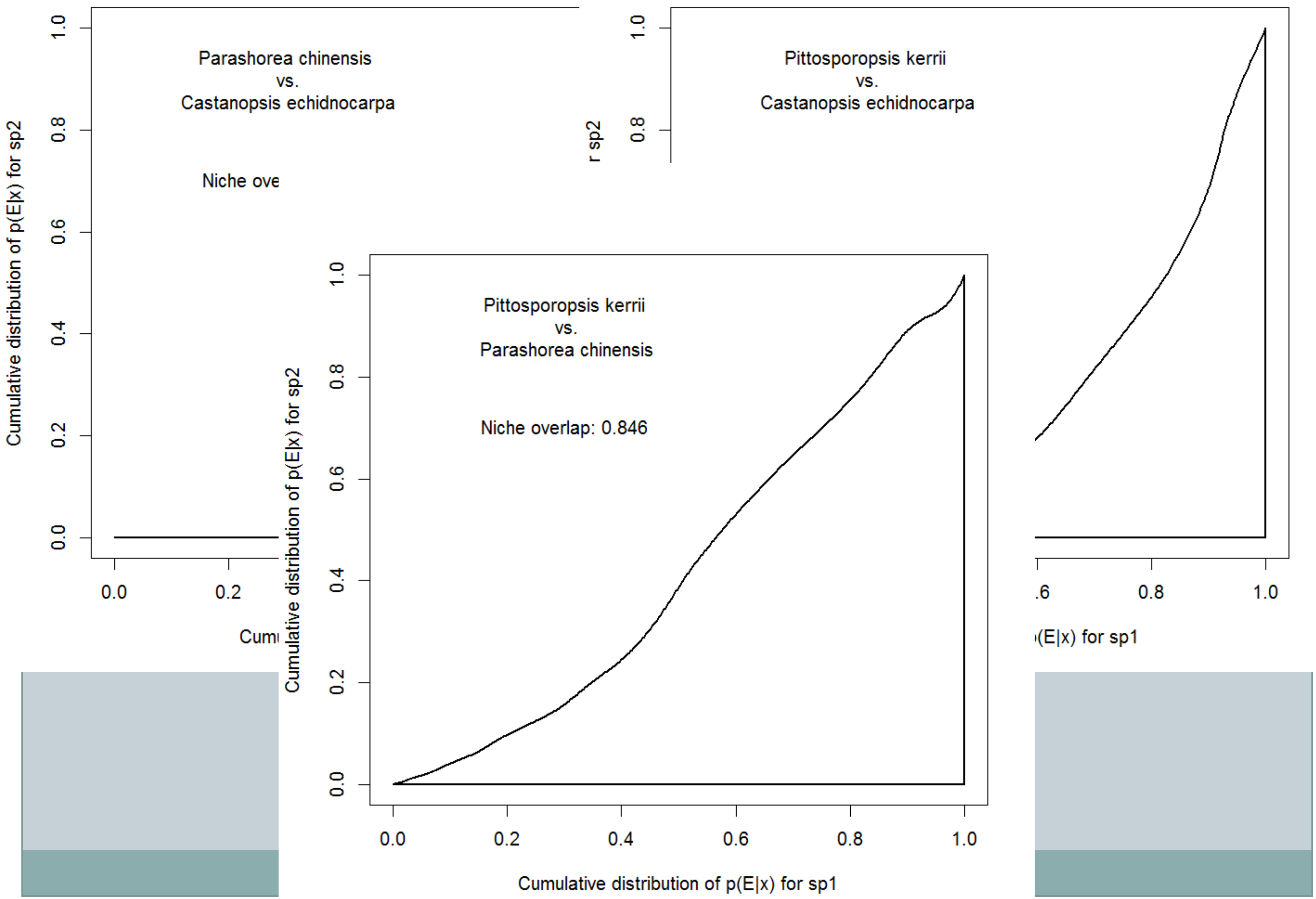
Pittosporopsis kerrii
1-5 cm DBH
5-10 cm DBH
10- cm DBH
p(E|x)
Density
Cumulative distributions of p(E|x)
Convexity
Niche breadth = 0.675
Cumulative proportion
Habitat variable in 0-1 scale



Parashorea chinensis
1-10 cm DBH
10-30 cm DBH
30- cm DBH
0
100
200
300
400
500
p(E|x)
0.15
0.10
Cumulative distributions of p(E|x)
Convexity
Niche breadth = 0.822
Cumulative proportion
0.0
0.2
0.4
0.6
0.8
1.0
Habitat variable in 0-1 scale



Castanopsis echidnocarpa
1-10 cm DBH
10-30 cm DBH
30- cm DBH
0
100
200
300
400
500
p(E|x)
Density
0.5
0.4
0.3
.2
Cumulative distributions of p(E|x)
Convexity
Niche breadth = 0.303
Cumulative proportion
0.0
0.2
0.4
0.6
0.8
1.0


Parashorea chinensis
vs.
Castanopsis echidnocarpa
Niche ove
Pittosporopsis kerrii
vs.
Castanopsis echidnocarpa
Pittosporopsis kerrii
vs.
Parashorea chinensis
Niche overlap: 0.846
Cumulative distribution of p(E|x) for sp2
Cumulative distribution of p(E|x) for sp1
0.0
0.2
0.4
0.6
0.8
1.0

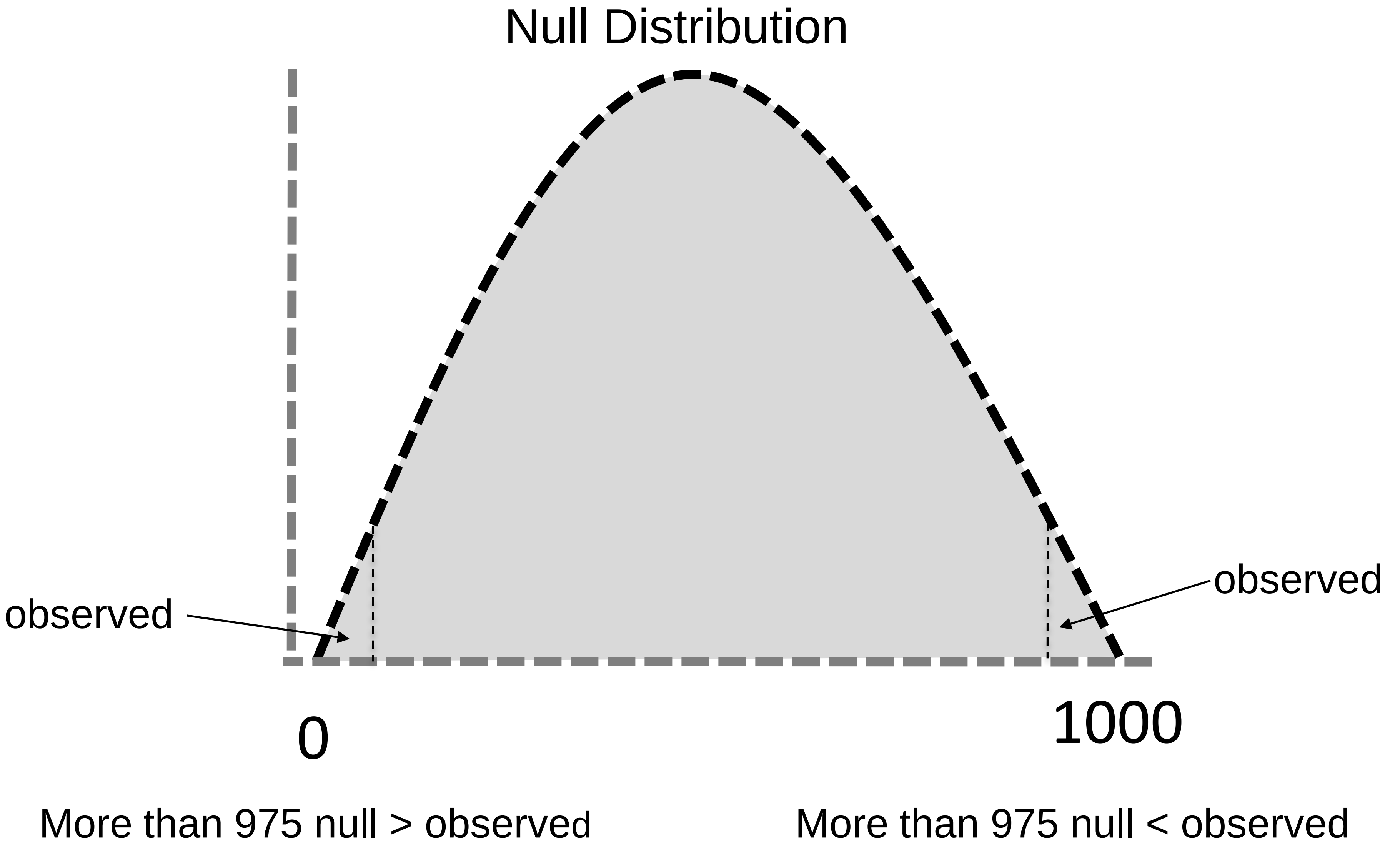
- 假如目标树种A和B在生境变量取值范围内没有生态位重叠，那么点对（$P_{\mathrm{A}}(E|x), P_{\mathrm{B}}(E|x)$）的曲线将沿着$P_{\mathrm{A}}(E|x)$轴和直线$P_{\mathrm{A}}(E|x)=1$或者沿着$P_{\mathrm{B}}(E|x)$轴和直线$P_{\mathrm{B}}(E|x)=1$，此时生态位重叠的值为0
- 假如目标树种A和B在生境变量取值范围内具有完全的生态位重叠，即具有完全一致的条件概率分布曲线及其累积分布曲线，那么点对（$P_{\mathrm{A}}(E|x), P_{\mathrm{B}}(E|x)$）的曲线将沿着45°线，此时生态位重叠的取值为1

生态位与中性在局域群落中的相对重要性

- Question 1: 生态位宽度/重叠的观察值是否真的由生境驱动产生?
- Question 2:生态位宽度/重叠的观察值是否也可以由散布限制来驱动产生?
  - 生态位宽度/重叠显著由生境驱动产生的树种/种对的比例
  - 生态位宽度/重叠也可以由散布限制来驱动产生的树种/种对的比例

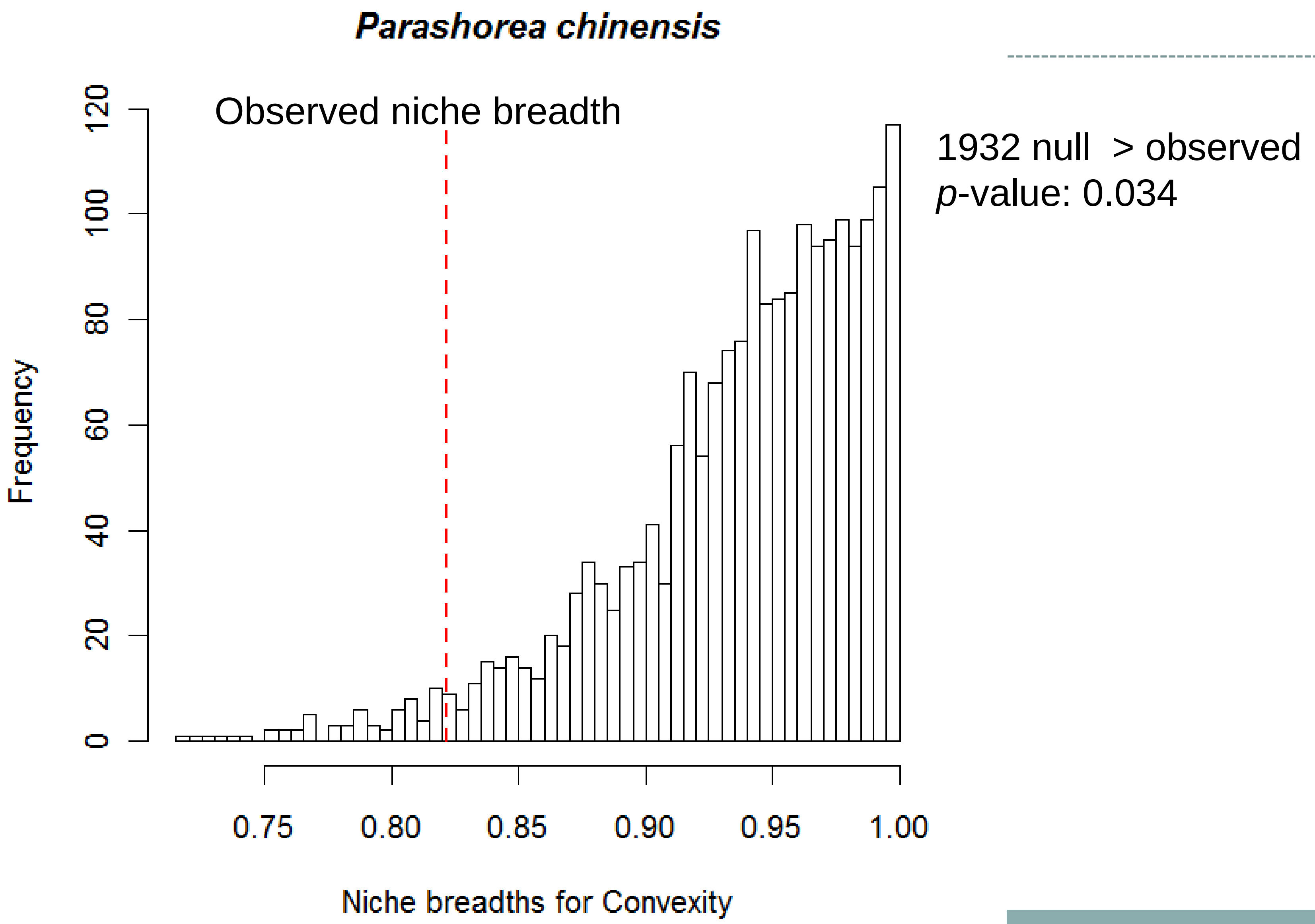
Null model

- **Torus-translation null model**: 维持种群和生境的空间结构不变，而改变二者的相对位置
- **Poisson-cluster null model**: 用Poisson cluster过程模拟散布限制驱动的种群空间分布格局

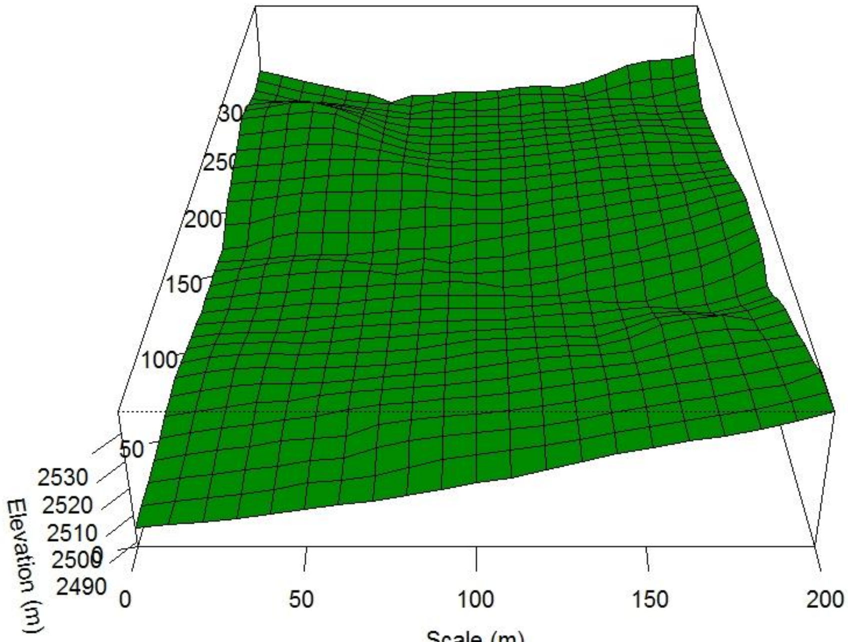


Monte Carlo simulation test

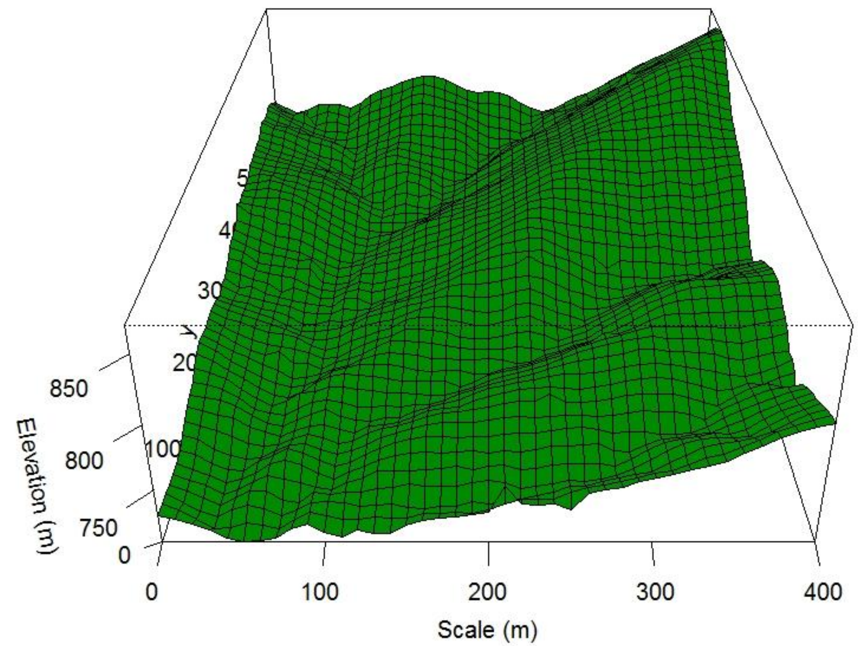
Histogram of null distribution under torus-translation null model



Case study from Xishuangbanna and Ailaoshan plots



Ailaoshan plot



Xishuangbanna plot

Relatively homogeneous topographic habitat
Relatively low species richness (13 sp. / ha)

Relatively heterogeneous topographic habitat
Relatively high species richness (24 sp. / ha)

Topographic complexity

- Topo_complexity=slope_area/project_area
- Xishuangbanna plot: 1.154

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- Ailaoshan plot: 1.033

Niche breadth

The number (percentage) of tree species with niche breadth significantly driven by the four topographic habitat variables under Torus-translation null model

	No. of sp.	Elevation	Convexity	Slope	Aspect
Ailaoshan	38[a]	7 (18.42)	2 (5.26)	6 (15.79)	7 (18.42)
Xishuangbanna	128[b]	41 (32.03)	70 (54.69)	16 (12.50)	8 (6.25)

[a]: no.of ind.>=30, dbh>=1 cm; [b]: no.of ind.>=100, dbh>=1 cm

- **In Ailaoshan plot, all the four topographic factors show weak niche-assembly processes**
- **In Xishuangbanna plot, convexity show relatively strong niche-assembly processes**
- **The more heterogeneous the habitat is, the more significant niche-assembly processes are!**

Niche breadth

The number (percentage) of tree species with niche breadth for the four topographic habitat variables which can be also maintained by dispersal limitation under Possion-cluster null model

	No. of sp.	Elevation	Convexity	Slope	Aspect
Ailaoshan	38[a]	26 (68.42)	33 (86.84)	31 (81.58)	26 (68.42)
Xishuangbanna	128[b]	80 (62.50)	60 (46.88)	106 (82.81)	115 (89.84)

[a]: no.of ind.>=30, dbh>=1 cm; [b]: no.of ind.>=100, dbh>=1 cm

- **In Ailaoshan plot, all the four topographic factors show strong dispersal-assembly processes**
- **In Xishuangbanna plot, convexity show relatively weak dispersal-assembly processes**
- **The more homogeneous the habitat is, the more significant neutral processes are!**

Niche overlap

The number (percentage) of species pairs with niche overlap significantly driven by the four topographic habitat variables under Torus-translation null model

Plots	No. of sp. pairs	Elevation	Convexity	Slope	Aspect
Ailaoshan	703[a]	142 (14.94)	74 (7.25)	117 (12.23)	133 (13.09)
Xishuangbanna	8128[b]	3588 (38.32)	4462 (49.53)	1276 (11.72)	421 (4.76)

[a]: 38 species (no.of ind.>=30, dbh>=1 cm) with 703 pairs; [b]: 128 species (no.of ind.>=100, dbh>=1 cm) with 8128 pairs.

- **The more heterogeneous the habitat is, the more significant niche-assembly processes are!**

Niche overlap

The number (percentage) of species pairs with niche overlap for the four topographic habitat variables which can also be maintained by dispersal limitation under Possion-cluster null model

	No. of sp. pairs	Elevation	Convexity	Slope	Aspect
Ailaoshan	1406[a]	1126 (80.09)	1255 (89.26)	1212 (86.20)	1134 (80.65)
Xishuangbanna	16256[b]	11021 (67.80)	9826 (60.45)	14273 (87.80)	14903 (91.68)

[a]: 38 species (no.of ind.>=30, dbh>=1 cm) with 1406 pairs; [b]: 128 species (no.of ind.>=100, dbh>=1 cm) with 16256 pairs; both species 1 versus species 2 and species 2 versus species 1.

- **The more homogeneous the habitat is, the more significant neutral processes are!**

Conclusions summary

- Our results **support** that the more heterogeneous the habitat is, the more significant niche-assembly processes are! or that the more homogeneous the habitat is, the more significant dispersal-assembly processes are!
- Our results are **against** that the more species there are in the community, the stronger dispersal limitation become (Hubbell's viewpoint).
- We further **hypothesize** that the relative importance of neutrality versus the niche may depend on the level of environmental heterogeneity, may not depend on the species richness (latitude).

Thank you for listening!

Any comment, question and suggestion?