Does Species Richness and Rarity Really Matter for Tropical Plant Conservation?

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Tropical Plant Conservation

This map shows the average threat level of plant life in different countries around the world.
Lepanthes spp. (Orchidaceae)

Scale Flowers/Babyboots

Mexico → Bolivia

≈ 1126 Species?

793 Rare/Endemics
Conservation Priorities

Conserving Biodiversity Coldspots
Recent calls to direct conservation funding to the world’s biodiversity hotspots may be bad investment advice

Peter Kareiva and Michelle Marvier
American Scientist (2003)

Global hotspots of species richness are not congruent with endemism or threat

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Conduct a geographical analysis that combines measures of richness, rarity, and threat to identify appropriate conservation targets.
Primary Questions

1) How are *Lepanthes* spp. geographically distributed?

Are there hotspots of richness or rarity and do they coincide?

Orme et al. (2005) *Nature*
2) Where are *Lepanthes* spp. threatened with extinction?

Do hotspots of richness & rarity coincide with extinction threat?
Primary Questions

3) What is the best course of action for preventing *Lepanthes* extinctions?

Which variables should we focus on?
Question 1: *Lepanthes* Distribution

Distribution Data (n = 4630)
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Question 1: *Lepanthes* Distribution

Sub-national species richness and rarity richness

[Maps showing distribution of *Lepanthes* species across the Americas with color-coded symbols indicating number of species per region.]
Question 1: *Lepanthes* Distribution

ArcGIS analysis: Hotspots & Getis-Ord Gi* Spatial Statistic

Sub-national species and rarity richness values

\[
G^*_i = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^{n} w^2_{i,j} - (\sum_{j=1}^{n} w_{i,j})^2}{n-1}}}
\]
Question 1: *Lepanthes* Distribution

Sub-national species richness and rarity richness hotspots

Significant hotspots of richness & rarity (n = 57)

Richness & rarity hotspots largely coincide (≈ 86%)
Primary Questions

2) Where are *Lepanthes* spp. threatened with extinction?

Do hotspots of richness & rarity coincide with extinction threat?
**Question 2: *Lepanthes* Extinction**

**Stochastic Extinction Model**


\[
E = a \sum_{n=1}^{y} b_n c^n
\]

\(E = \text{extinction (# of spp.)}\)  \(b_n = \text{proportion of species found at } n \text{ localities}\)

\(a = \text{total # of species}\)  \(c = \text{deforestation rate}\)
Question 2: *Lepanthes* Extinction

Species Richness (Per Country)

\[ a = \text{total \# of spp.} \]

- **Ecuador**: 450 spp.
- **Colombia**: 300 spp.
- **Costa Rica**: 200 spp.
- **Bolivia**: 150 spp.
- **Guatemala**: 100 spp.
- **Mexico**: 50 spp.
- **Peru**: 50 spp.
- **Venezuela**: 50 spp.
- **Panama**: 50 spp.
- **Dominican Republic**: 50 spp.
- **Cuba**: 50 spp.
- **Jamaica**: 50 spp.
- **Haiti**: 50 spp.
- **El Salvador**: 50 spp.
- **Honduras**: 50 spp.
- **Nicaragua**: 50 spp.
- **Puerto Rico**: 50 spp.
- **Belize**: 50 spp.
- **Brazil**: 50 spp.
- **French Guiana**: 50 spp.
- **Suriname**: 50 spp.
- **Guadeloupe**: 50 spp.
- **Guyana**: 50 spp.
- **Saint Lucia**: 50 spp.
Question 2: *Lepanthes* Extinction

Distribution Profiles (Frequency Histograms)

\[ b_n = \text{proportion of spp. at } n \text{ sites} \]
Question 2: *Lepanthes* Extinction

Distribution Profiles (Frequency Histograms)

Skew:

\[ g_1 = \frac{n}{(n-1)(n-2)} \sum_{i=1}^{n} \left( \frac{x_i - \bar{x}}{s} \right) \]
Question 2: *Lepanthes* Extinction

National deforestation data
(mean annual conversion rate 1990-2010)

\[ c = \text{deforestation rate} \]
Question 2: *Lepanthes* Extinction

Projected species extinctions (50 years)

\[ E = a \sum_{n=1}^{y} b_n c^n \]

\[ E = 194 \text{ species} \]
Question 2: *Lepanthes* Extinction

Projected extinction probability (50 years)

\[
\frac{\text{# of spp. extinct}}{\text{Total # of spp.}}
\]

Mean extinction probability \(\approx 13.6\%\)
Question 2: *Lepanthes* Extinction

Greatest predicted species losses:

Ecuador, Guatemala, Colombia, Panama, Venezuela
Question 2: *Lepanthes* Extinction

Greatest predicted probability of extinction:

Honduras, El Salvador, Guatemala, Haiti, Ecuador
3) What is the best course of action for preventing *Lepanthes* extinctions?

Which variables should we focus on?
Question 3: *Lepanthes* Conservation

Non-parametric regression model:

R statistical software - Random Forest package
Question 3: *Lepanthes* Conservation

**Five independent variables:**

- Richness
- Rarity measures
- Deforestation

**Dependent variable:** Extinction probability
Question 3: *Lepanthes* Conservation

Sample trees from Random Forest:

- 53% of variation explained by the model
Deforestation = 31.58% increase in MSE when permuted
Question 3: *Lepanthes* Conservation

**Reservation strategies: current status**

- % of country protected in reserves
- % of richness hotspots protected
- % of rarity hotspots protected

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UN Environment Programme World Conservation Monitoring Centre 2010
Conclusions

1) *Lepanthes* distribution
- Hotspots are potential conservation targets
- Conservation efforts will be most efficient here
Conclusions

2) *Lepanthes* extinction

- Species & rarity richness ≠ extinction or threat
- Conservation efforts are **most urgent** here
3) *Lepanthes* conservation

-Habitat loss is the best predictor of extinctions

-Conservation will be most effective if focused on threatened hotspots

![Diagram showing the relationship between Richness, Rarity, and Threat with Conservation Targets at the intersection.](image-url)