

The ecology of plant extinction: rates, traits and island comparisons

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SUPPLEMENTARY TABLE 1 Ecological characteristics of extinct plant species from islands and continents, and species from islands that are categorized as Critically Endangered and also have declining populations. Numbers are species within each category (data from from BHL, 2017; Heywood et al., 2007; IUCN, 2017; JSTOR, 2017; Kew, 2017; MOBOT, 2017; and herbarium specimens where available).

Category	Characteristic	Extinct species			CR species ¹
		Continental	Island	Global	
Life Form	Bryophyte	2		2	1
	Cycad	4		4	6
	Fern	1	2	3	
	Herb	6	15	21	45
	Herb/Shrub	1	1	2	
	Liana				5
	Orchid		1	1	12
	Parasitic				2
	Palm	2		2	
	Shrub	11	43	54	82
	Succulent	1		1	4
	Tree	19	29	48	84
	Life Cycle	Annual	1	2	3
Annual/perennial		1		1	
Biennial			1	1	
Perennial		45	88	133	236
Perennial/biennial					1
Main pollinators/fertilization	Non specific animal ²				73
	Birds		25	25	12
	Birds/invertebrates		1	1	
	Invertebrates	36	56	92	109
	Fern				1
	Self	1	1	2	
	Water	3	2	5	
	Wind	7	6	13	21
Main Dispersal	Wind/invertebrates				27
	Animal	29	55	84	87
	Ballistic				9
	Barochory	6	16	22	81
	Birds		1	1	4

	Water	1		1	1
	Wind	11	19	30	61
Habitat	Bogs		1	1	
	Caves		1	1	
	Cliffs				21
	Coastal	1	2	3	10
	Cupriferous Savanna–steppe	2		2	
	Desert		2	2	1
	Fern sward		1	1	
	Forest	33	67	100	174
	Fresh water				2
	Grassland	4	5	9	5
	Hot springs	1		1	
	Limestone	1		1	14
	Mangrove				3
	Mountains				4
	Other wet habitats	2	2	4	
	Serpentine soil				1
	Shrubland	3	9	12	7
	Unknown		1	1	
	Volcanic substrate				2
Roots	Adventitious	2		2	27
	Bulb				1
	Corn				3
	Fibrous		2	2	
	None	2		2	3
	Parasitic		1	1	
	Rhizome	5	18	23	43
	Stem				1
	Tap root	38	70	108	163
	Tuber				2
Breeding system	Dioecious	2	1	3	44
	Monoecious	45	90	135	199
Fruit	Achene	3	11	14	29
	Berry	15	28	43	52
	Capsule	10	29	39	65
	Caryopsis	1	2	3	5
	Cone	4		4	13
	Drupe	5	6	11	32
	Follicle	2	2	4	4
	Legume	2	3	5	17
	Mericarp		1	1	4
	Nut	2	2	4	7
	Nutlet		2	2	
	Schizocarp		1	1	11

	Siliqua		2	2	4
	Spore	3	2	5	
Endosperm/perisperm	Absent	15	43	58	93
	Present	32	48	80	150
Woodiness	N	10	25	35	75
	Y	37	66	103	168
Number of seeds	1	15	27	42	99
	2	5	6	11	12
	3	2	6	8	12
	4		6	6	6
	5	1	7	8	4
	6	1		1	4
	7		1	1	3
	8	1		1	3
	9				1
	10	1		1	1
	>10	21	38	59	98
Flower type	Regular	29	41	70	106
	Irregular	10	48	58	123
	N/A	8	2	10	14

¹Number of Critically Endangered species with declining populations

²Pollination is known be carried out by animals but the type of animals have either not been specified or are multiple animal types.

References

BHL (2017) *The Biodiversity Heritage Library*. The BHL consortium, Washington, DC, USA. <https://www.biodiversitylibrary.org> [accessed 1 August 2017].

HEYWOOD, V.H., BRUMMITT, R.K., CULHAM, A. & SEBERG, O. (2007) *Flowering Plant Families of the World*. Kew Publications, London, UK.

IUCN (2017) *The IUCN Red List of Threatened Species. Version 2017-1*. <http://www.iucnredlist.org> [accessed 22 August 2017].

JSTOR (2017) *Global Plants on JSTOR*. <https://plants.jstor.org> [accessed August 2017].

Kew (2017) *Electronic Plant Information Centre (ePIC)*. Royal Botanic Gardens Kew, London, UK. <http://epic.kew.org> [accessed 1 August 2017].

MOBOT (2017) *Tropicos*. Missouri Botanic Garden, Missouri, USA. <http://www.tropicos.org> [accessed 1 August 2017].

SUPPLEMENTARY MATERIAL 1 Draft example of a proposed motion on island genetic diversity that could be presented to the IUCN World Conservation Congress.

Integrating native and endemic island genetic diversity into conservation objectives

RECALLING the three interdependent components of biodiversity: genetic, species and ecosystem diversity;

RECOGNISING the disproportionate importance of island biodiversity to the global biodiversity pool;

RECOGNISING the historical, present and future importance of island biodiversity to the scientific inquiry of the evolution of life on earth;

ALARMED at the historic, present and potential for future loss of island species from the global species pool;

NOTING that the conservation of genetic diversity is not sufficiently taken into account in island conservation programmes;

REGRETTING the lack of long-term conservation programmes on islands, and the lack of involvement of island species genetic diversity in short- and long-term conservation programmes;

ALSO RECALLING the objectives of the *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity*, to contribute to the conservation and sustainable use of island biodiversity;

RECOGNISING the importance, for the medium- and long-term, of a dynamic conservation of island genetic diversity, which favours the adaptive capacities and evolution of island native and endemic species in the face of environmental changes;

ALSO RECOGNISING that the genetic diversity of island species is a key component in island biodiversity and that, in part, it determines the functioning of the other components of the biodiversity of island ecosystems;

RECOGNISING the role of the genetic biodiversity of island species in the resilience and adaptation of island ecosystems to the direct and indirect effects of climate change; and

FINALLY RECOGNISING the need to set up networks of organisations and institutions that will focus on important island species with added value for food, trade, tourism, industrial

benefits (medicine, aromatic plants, etc.), scientific importance, key ecological roles and the environmental characteristics for the control of climate change at national, regional and international levels;

The World Conservation Congress, asks to:

- a. promote the taking into account of native and endemic island genetic diversity conservation at all levels of action (local, national, global);
- b. improve the integration of the conservation of native and endemic island genetic diversity into the conservation goals for protected areas, in order to:
 - i. take this key component of island biodiversity fully into account; and
 - ii. reinforce the resilience and adaptation of island ecosystems to the direct and indirect effects of climate change, habitat destruction and species invasions;
- c. recognise a protected area protection status (Category IV) corresponding to the conservation units of island genetic diversity selected within the framework of national and/or international programmes, as a result of:
 - i. their contribution to an in situ conservation network representative of the genetic variability of island species; and
 - ii. the existence of in situ management measures, established in a management document, aimed at maintaining the genetic diversity of the species involved and to favour their adaptation to environmental changes;
- d. encourage and facilitate the creation, expansion, monitoring and documentation of genetic resources both ex situ and close to the sites, through seed banks, orchards, provenance trials and other in vivo collections of different islands species in order to:
 - i. facilitate the equitable and sustainable use of genetic resources of important island species and those with added value.

Supplementary Table 2 Minimum requirements for genetic conservation units of island native and endemic species under the example proposed motion in Supplementary Material 1.

Requirement group	Detailed requirements
Basic requirements	<p>The unit has</p> <ul style="list-style-type: none"> (1) a designated status as a genetic conservation area of island species, recognized by the appropriate authorities or agencies in a country (2) a management plan in which genetic conservation of island species is recognized as a major management goal <p>One or more island species have been recognized as target species for genetic conservation in the management plan</p> <p>One of the following conservation objectives has been clearly stated for each target species within a unit:</p> <ul style="list-style-type: none"> (1) to maintain genetic diversity in large island populations; (2) to conserve specific adaptive or other traits in rare or fragmented populations; or (3) to conserve rare or endangered island species with populations consisting of a small number of remaining individuals
Population size	<p>The minimum population size depends on the conservation objective, as follows:</p> <p>Case 1: If the purpose of the unit is to maintain genetic diversity of widely occurring and habitat forming species, the unit must consist of 500 or more reproducing plants</p> <p>Case 2: If the unit was established to conserve specific adaptive or other traits in marginal or fragmented populations, the unit must harbour a minimum of 50 reproducing individuals or, in the case of dioecious species, 50 seed bearing plants.</p> <p>Case 3: If the unit is aiming to conserve remaining populations of rare or endangered island species, it must harbour a minimum of 15 unrelated reproducing plants.</p> <p>Case 4: Where the unit is aiming to conserve remaining populations of rare or endangered island species below 15 unrelated reproducing plants there must be significant potential for vegetative reproduction and/or a lack of self-incompatibility mechanisms and/or sufficient related congeners with which to attempt a breeding programme.</p>
Management	<p>Management interventions are allowed and encouraged where appropriate within the unit and they are actively applied, as needed, to:</p> <ul style="list-style-type: none"> (1) ensure the continued existence of target island populations; and (2) create favourable conditions for growth and vitality of the target island species and their natural regeneration
Monitoring	<p>Field inventories are carried out every 5–10 years to assess regeneration success and population size, and to update the management plan</p> <p>Between the inventories, the units are visited regularly to observe that they still serve their purpose and that they have not been damaged or destroyed</p>