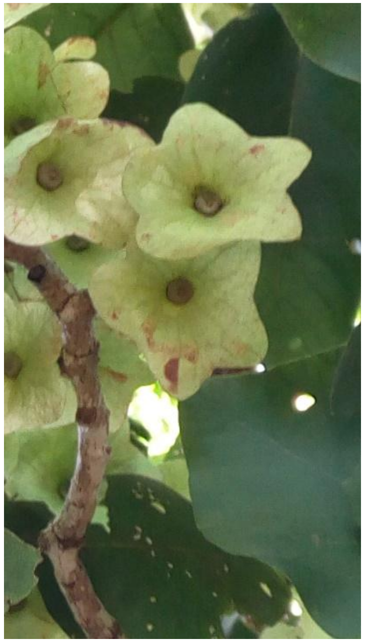
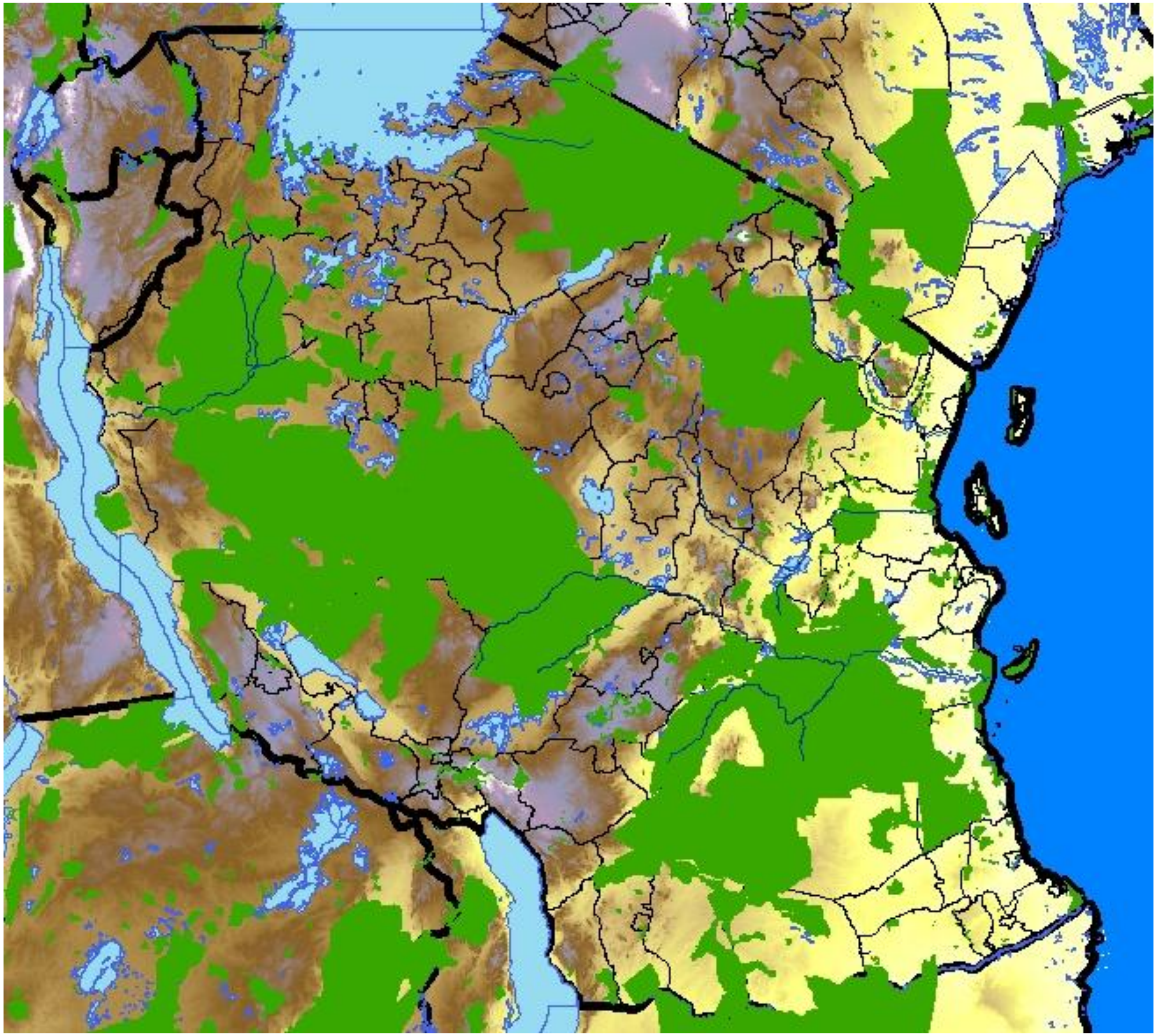


Saving Tanzanian Trees from Extinction

Practice for threatened tree conservation. Highlighting the importance of species-specific conservation

Fandey H. Mashimba (MSc.)
Seed Biology Manager
Tanzania Forest Service Agency

About one-third of Tanzania's land area is covered by protected areas: Nature Reserves, National Parks, Forest Reserves, Game Reserves, etc.



Biodiversity

- Genetic Diversity, Species Diversity & Ecosystem Diversity
- **<u>Importance</u>**
  - Medical
  - Pharmaceutical
  - Economic
  - Aesthetic
  - Recreational
  - Ecological – all species interact / r
  - Purification of air and water
  - Detoxification and decomposition of wastes
  - Nutrient Cycling
  - Species uniqueness

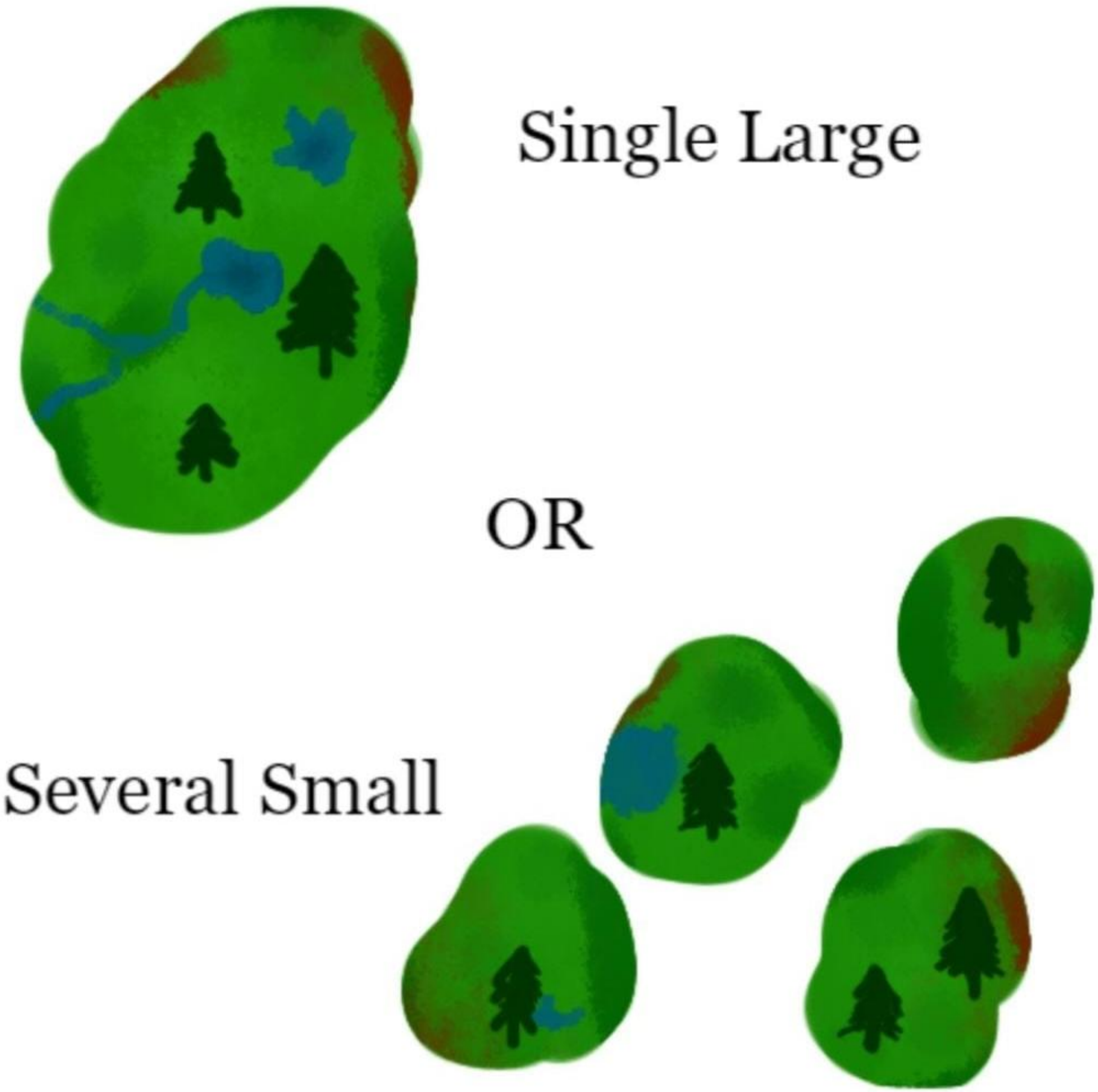
Biodiversity: Human welfare

- 25% of all medical prescriptions
- Genetic variability
- Aesthetic and ethical reasons
- Species survival

Biodiversity crisis

- **Extinction** - natural phenomenon, however, rate is of concern…..
- 50% loss of species when 90% of habitat is lost
- Major Threats:
- **Habitat destruction** - single greatest threat; cause of 73% of species designation as extinct, endangered, vulnerable, rare; 93% of coral reefs
- **Competition by exotic (non-native) species** - cause of 68% of species designation as extinct, endangered, vulnerable, rare; travel
- **Overexploitation** - commercial harvest or sport fishing; illegal trade

SLOSS "Single Large or Several Small?.



- It refers to two different approaches to land conservation in order to protect biodiversity in a given region.

SLOSS "Single Large or Several Small? Cont…

- ❑The "single large" approach favors one sizeable, contiguous land reserve (landscape).
- ❑ The "several small" approach favors multiple smaller reserves of land whose total areas equal that of a large reserve.
- ❑ If several smaller reserves each contained unique species, then it would be possible for smaller reserves to harbor even more species than a single large reserve thus its value as HCV area.
- ❑ Contiguous areas, beneficial to communities of interdependent species and also more likely to support populations of species that occur at low population densities, particularly rare trees and threatened species

Fragmented SLOSS "Single Large or Several Small?

- Fails to support and disconnect species that need a large territory.
- Make it difficult for species that needs with wide pollination and dispersal niche breadth to survive and perpetuate.
- Makes species that have wide dispersal niche breadth to retreat into smaller reserves of habitat (end up crowded, increasing competition for resources and disease transmission).
- Interrupting continuity and decreasing the total area of available habitat
- Cause and magnifies the so called "edge effect". This effect negatively impacts species that are adapted to interior habitats because they become more vulnerable disturbances.

Regional and Local Stats about Biodiversity

- We are eliminating species faster than we discover new ones
- We cut down forests before we've had a chance to document or study what was there
- We replace our diverse vegetation with monocultures
- We are polluting the environment faster than nature can respond and adapt
- We worry about an endangered or extinct species after it is to late

Resource management and conservation biology focus

- **Preservationism:** setting side select areas as natural and underdeveloped

- **Resource conservation:** public lands to meet the needs of agriculture and extractive industries, i.e., ”multiple use”

- **Evolutionary / ecological view:** natural systems result from millions of years of evolution and ecosystem processes are necessary to maintain the biosphere.

The Goal

- **Conservation Biology**
  - Integrates all areas of biology to sustain ecosystems and preserve biodiversity
- **Restoration Ecology**
  - Uses ecology to return degraded ecosystems to their natural state
  - Considerations are spearheaded by looking so called High Conservation Values
  - There should be an approach of using so called HCV framework.

What is the HCV Framework?

- A practical conservation tool for ensuring that **critical values** in natural and production landscapes are identified, managed, and monitored.
- In the context of land use planning, ensures that **critical areas** are prioritised for conservation management.
- Developed in the context of forest certification (FSC, 1999) but relevant to all kinds of ecosystems and habitats.
- **Value driven:** covers **biodiversity and ecosystem** values as well as **social and cultural** values

The six High Conservation Values

- Biodiversity
- Landscapes
- Ecosystems
- Ecosystem services
- Basic human needs
- Cultural identity

The six High Conservation Values cont…

- **HCV1-i.e. Biodiversity** - Areas containing globally, regionally or nationally **significant concentrations of biodiversity values** (e.g. endemism, endangered species, refugia). Notably biodiversity hostspots

- **HCV2 –i.e Landscapes** - Globally, regionally or nationally significant **large landscape-level areas** (e.g. forests) where **viable populations** of most if not all naturally occurring species exist in **natural patterns of distribution and abundance**.

- **HCV3 i.e. Ecosystems** - Areas that are in or contain **rare, threatened or endangered ecosystems**.

- **HCV4-i.e. Ecosystem services** - Areas that provide **basic ecosystem services in critical situations** (e.g. watershed protection, erosion control).

- **HCV 5** i.e. **Basic human needs-** Areas fundamental to meeting **basic needs of local communities** (e.g. subsistence, health).

- **HCV6 i.e. Cultural identity** - Areas critical to **local communities' traditional cultural identity** (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

The HCV process

Identify

- **What** are the potential HCVs in this region?
- Which values **occur** in the area?
- **Where** are these values located?

Manage

- What are the existing **threats** to the values?
- Habitat **area** needed to maintain the values?
- How should habitat be **managed**?

Monitor

- **What** needs to be monitored?
- **How** will monitoring be done?
- How will the **results** of monitoring be used?

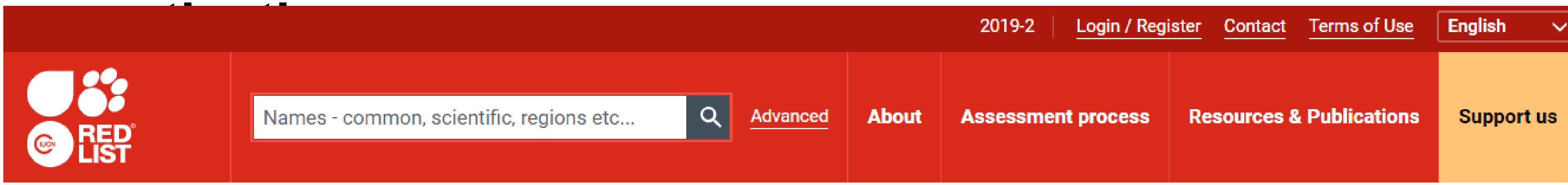
Consultation

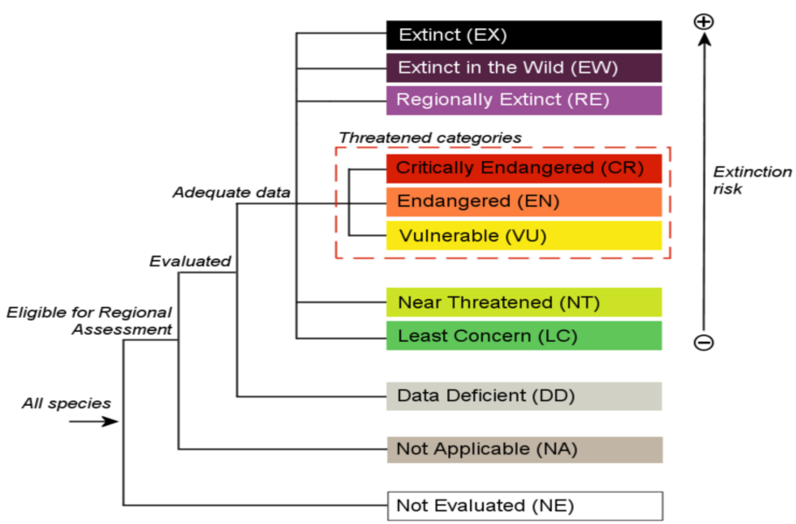
Safeguards

- ❑HCV is a decision-making framework: not a stand-alone guarantee of sustainability
- ❑Precautionary approach: Case study Production forests
- ❑Issues of land tenure and legality need to be addressed
- ❑Can only operate where governance allows
- ❑Requires monitoring to ensure management works to maintain values
- ❑*Conversion of natural ecosystems poses an irreversible threat to HCVs: assessment process must, as far as possible eliminate uncertainty prior to any conversion activity*

REDLIST FOR ECOSYSTEMS

- This should not be confused with previous redlist for plant species
- **The IUCN Red List of Threatened Species provides a global standard for assessing the risk of species**





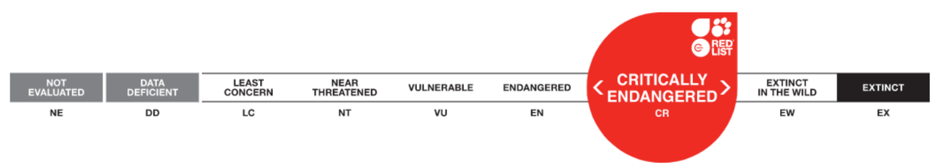
Karomia gigas

ABSTRACT

Karomia gigas has most recently been assessed for *The IUCN Red List of Threatened Species* in 2021. *Karomia gigas* is listed as Critically Endangered under criteria D.

THE RED LIST ASSESSMENT

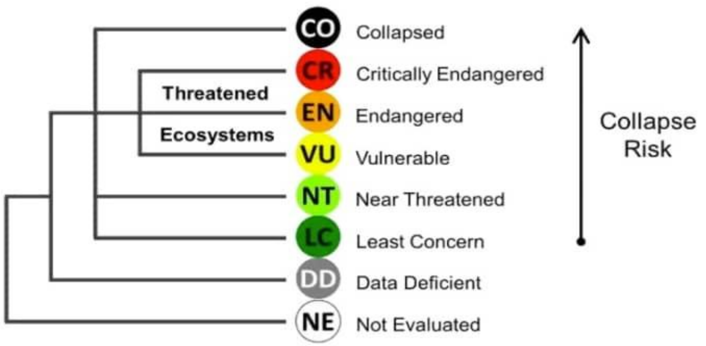
Fandey H.M. & Shaw, K. 2022. *Karomia gigas* (amended version of 2021 assessment). *The IUCN Red List of Threatened Species* 2022: e.T35173A213968411. https://dx.doi.org/10.2305/IUCN.UK.2022-1.RLTS.T35173A213968411.en. Accessed on 02 May 2023.



REDLIST FOR ECOSYSTEMS

- **The IUCN redlist of ecosystems is a global standard for how we assess the status of ecosystems.**
- The tool is based on scientific criteria for performing evidence-based analyses of the risk of ecosystem collapse, including changes in geographical distribution and the degradation of the key elements of ecosystems.

The IUCN risk categories

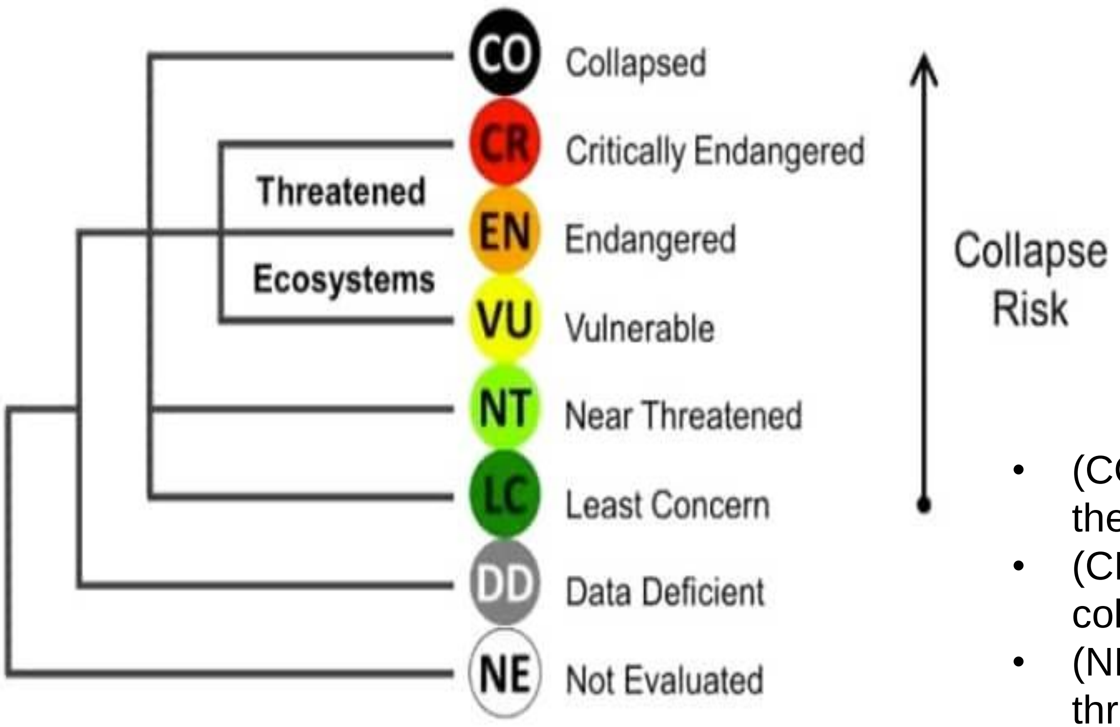


Structure of the IUCN Red List of Ecosystems categories.

In descending order of threat, the eight IUCN Red List of Ecosystems risk categories are: *Collapse (CO),Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NE), Least Concern (LC), Data Deficient (DD) and Not Evaluated (NE):*

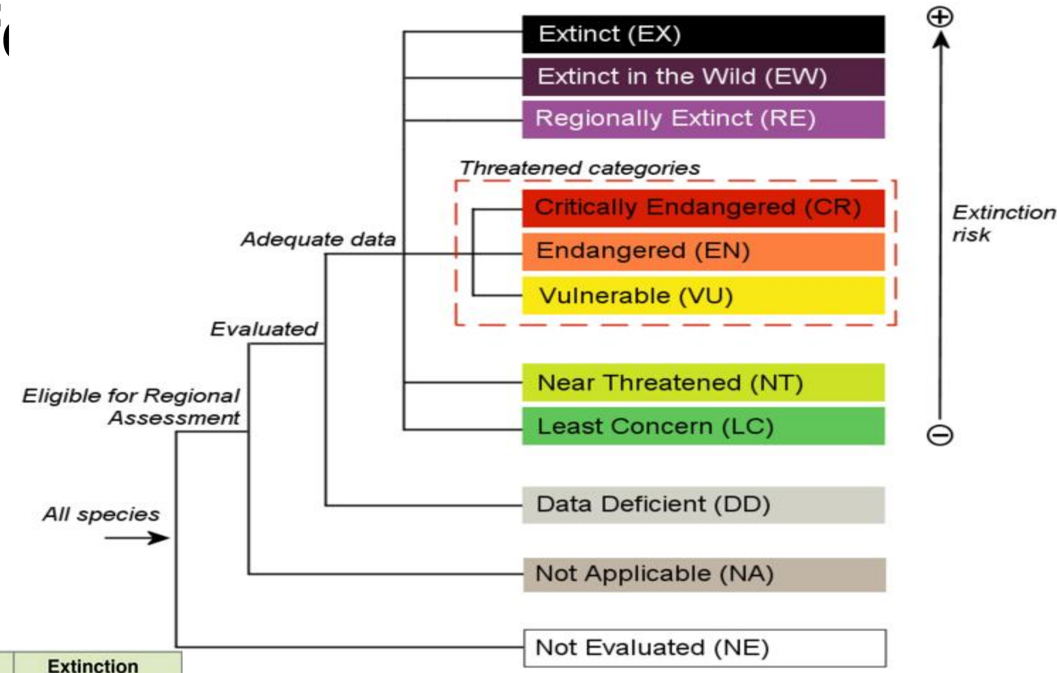
Comparisons between redlist for plant species and **Redlist for Ecosystems**

Structure of the IUCN Redlist for ecosystems



- (CO): ecosystems collapsed throughout the assessed distribution
- (CR), (EN), (VU): ecosystems facing collapse
- (NE): ecosystems close to the threatened threshold or threatened without ongoing conservation measures in the future
- (LC): ecosystems evaluated as at low risk of collapse
- (DD): ecosystems for which too few data exist
- (NE): ecosystems that have not yet been assessed.

Comparisons between redlist for plant species and **Redlist f**



Structure of the IUCN Redlist for plant spe

	Population Reduction Rate	Geographic Range: Extent of Occurence	Geographic Range: Area of Occupancy	Population Size	Population Restrictions	Extinction Probability (in the wild)
Least Concern	A species that has a widespread and abundant population					
Near Threatened	A species that is likely to qualify for a threatened category in the near future					
Vulnerable Species	30-50% population decline	<20,000 km²	<2,000 km²	<10,000 mature individuals	<1,000 mature individuals or an area of occupancy of <20 km²	at least 10% within 100 years
Endangered Species	50-70% population decline	<5,000 km²	<500 km²	<2,500 mature individuals	<250 mature individuals	at least 20% within 20 years or 5 generations
Critically Endangered	≥80-90% population decline	<100 km²	<10 km²	<250 mature individuals	<10 mature individuals	at least 50% within 10 years or 3 generations
Extinct in the Wild	Only survives in cultivation (plants), in captivity (animals), or as a population well outside its established range					
Extinct	No remaining individuals of the species					

IUCN and its role in conservation of BD

- IUCN Species Survival Commission (SSC)
- Draw up **Red list** of threatened species
- Review, revise and update the lists regularly
  - Provide guidelines for such assessment

IUCN cont'd

- NOTE:
- The world 'Threatened' has no definition in IUCN Redlist categories, but generally it includes:

  - taxa that are endangered, vulnerable, rare or indeterminate

_ (no legal definition as used in TZ)

IUCN Category	TANZANIA	KENYA	UGANDA	DRC (ZAIRE)
•EX	2	0	0	0
•EW	0	0	0	0
•Subtotal	2	0	0	0
•CR	8	5	2	0
•EN	33	14	4	12
•VU	199	84	32	53
•Subtotal	240	103	38	65
•LR/cd	2	1	1	3
NT	17	26	9	14
DD	7	1	1	2
LC	17	15	9	13
Total	285	146	58	97

Despite concerted efforts by the Government of Tanzania and numerous national and international organizations, 314 Tanzanian tree species are in the three IUCN Red List threatened categories (VU, EN, CR), with 44 more assessed as Near Threatened (NT).

1	Family	Species name	IUCN category
2	Anacardiaceae	*Searsia brenanii* (Kokwaro) Moffett	VU B2ab(iii)
3	Anacardiaceae	*Sorindeia calantha* Mildbr.	VU B2ab(iii)
4	Annonaceae	*Annickia kummerae* (Engl. & Diels) Setten & Maas	EN B1ab(iii)
5	Annonaceae	*Asteranthe lutea* Vollesen	EN B2ab(iii)
6	Annonaceae	*Greenwayodendron usambaricum* (Verdc.) Lissambou, O.J. Har	EN B1ab(ii,iii,v)
7	Annonaceae	*Huberantha stuhlmannii* (Engl.) Chaowasku	VU B1ab(ii,iii,v)
8	Annonaceae	*Huberantha tanganyikensis* (Vollesen) Chaowasku	EN B1ab(ii,iii,v)
9	Annonaceae	*Huberantha verdcourtii* (Vollesen) Chaowasku	EN B1ab(ii,iii,v)+2ab(ii,iii,v)
10	Annonaceae	*Isolona cauliflora* Verdc.	EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)
11	Annonaceae	*Isolona heinsenii* Engl. & Diels.	EN B1ab(iii)
12	Annonaceae	*Isolona linearis* Couvreur	VU B2ab(iii)
13	Annonaceae	*Mkilua fragrans* Verdc.	VU B1ab(iii)
14	Annonaceae	*Monanthotaxis discolor* (Diels) Verdc.	EN B2ab(iii)
15	Annonaceae	*Monodora carolinae* Couvreur	EN B1ab(iii)+2ab(iii)
16	Annonaceae	*Monodora globiflora* Couvreur	NT
17	Annonaceae	*Monodora hastipetala* Couvreur	CR B1ab(iii)+2ab(iii)
18	Annonaceae	*Monodora minor* Engl. & Diels	NT
19	Annonaceae	*Polyceratocarpus scheffleri* Engl. & Diels	EN B1ab(i,ii,iii,iv,v)
20	Annonaceae	*Sanrafaelia ruffonammari* Verdc.	EN B1ab(iii)+2ab(iii)

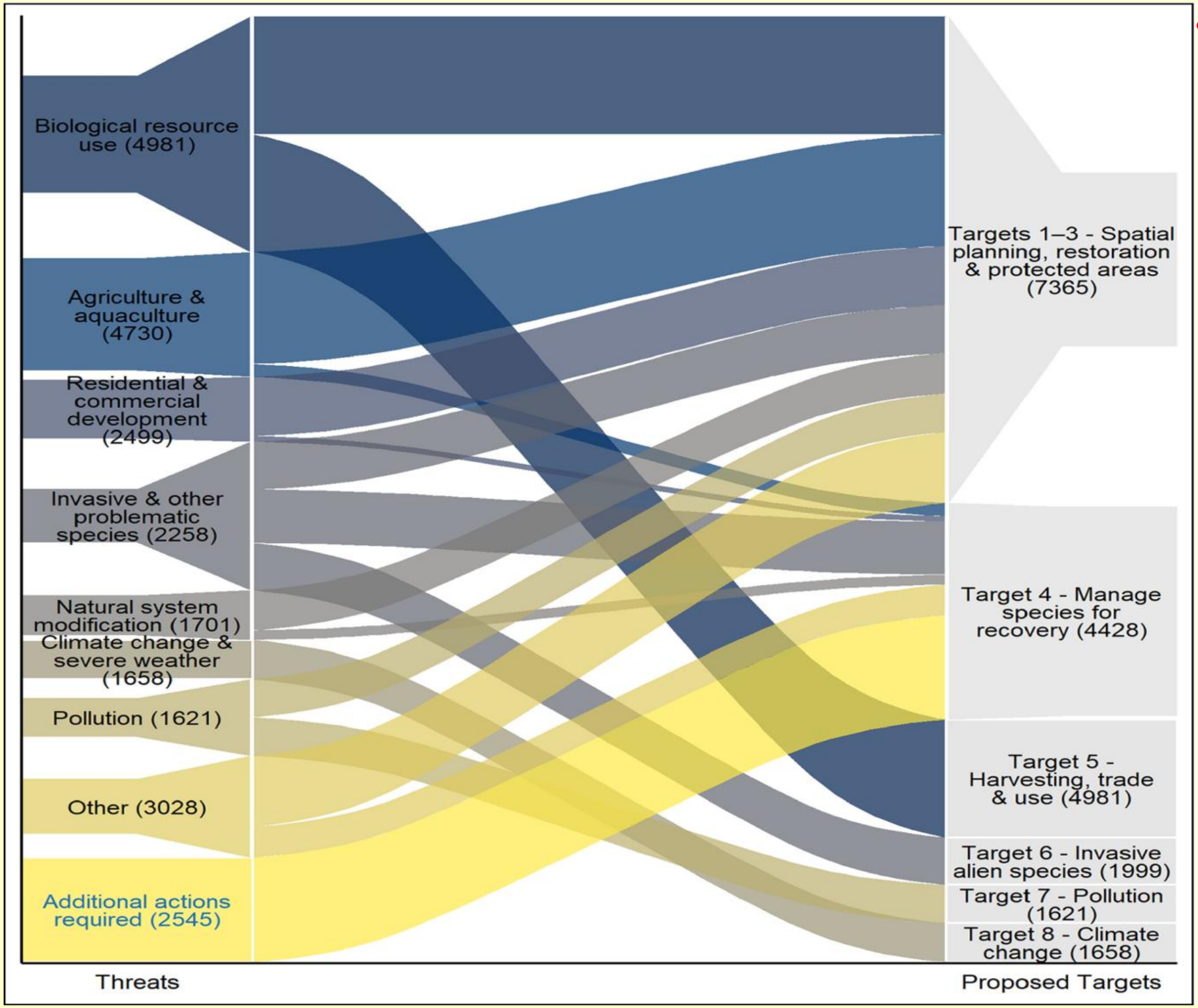
Species specific conservation action

- A staggering 57% of threatened species need targeted recovery actions to ensure their survival, to avert human-induced extinction
- Number of threatened and Extinct in the Wild species whose threats are addressed by the proposed post-2020 targets for all comprehensively assessed species groups on the International Union for Conservation of Nature (IUCN) Red List (n = 7784 species).
- Species can be affected by more than one threat, and threats can be tackled by more than one target.

Species specific conservation action

- that while targets to expand protected areas or reduce pollution will benefit many species, 57% would still need targeted recovery actions.
- These actions include captive breeding in zoos, reintroduction into the wild, moving individuals between locations, vaccination against disease, and other species-specific interventions.
- Many will benefit from policies and actions designed to reduce threats from land- use change, overexploitation, pollution, invasive species and climate, but these alone will not remove the risk of extinction that these species face.
- Now, we can identify the species that need such action, and we can monitor what is being done and what the impact of action is on those threatened species."

Species specific conservation action



Frontiers in Ecol & Environ, Volume: 21, Issue: 2, Pages: 64-70, First published: 18 July 2022, DOI: (10.1002/fee.2537)

- Colors distinguish different threats. Threats are classes in level 1 of the IUCN Red List Threats Classification Scheme; “Other” includes the classes “Energy production and mining”, “Transportation and service corridors”, “Human intrusions and disturbance”, and “Other options”. “Additional actions required” refers to species requiring species-specific conservation actions as listed on the IUCN Red List Actions Classification Scheme (that is, “Ex situ conservation”, “Species reintroduction”, and “Species recovery”), and/or that require such actions because they have very small populations or ranges. Figures in parentheses indicate the number of species.

Case studies: Tackling species extinctions

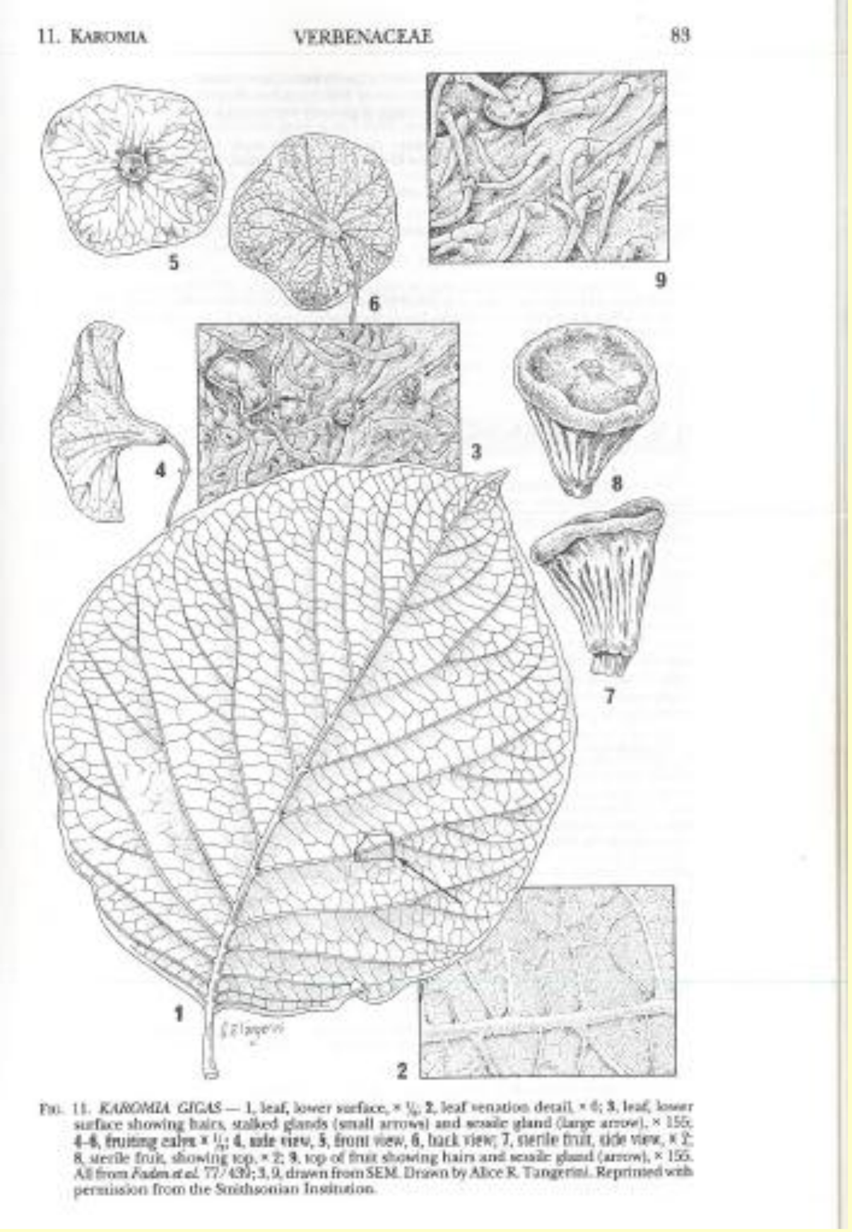
- The research was based on 7,784 species listed as 'Vulnerable', 'Endangered', and 'Critically Endangered' in the IUCN Red List of Threatened Species.
- The team considered the targets in the first draft of the UN Convention on Biological Diversity's Global Biodiversity Framework.
- The scientists assessed the potential benefits to each threatened species of implementing each target.
- They found that Target 1 (on implementing spatial planning to retain existing intact ecosystems), Target 2 (on restoring degraded ecosystems and ensure connectivity among them), and Target 3 (on protecting important areas for biodiversity) will be particularly important, as 95% of threatened species would benefit from their implementation.

Case studies: Tackling species extinctions

- The data also show, however, that these actions, and those for targets 5-8 on reducing pressures from unsustainable use, invasive species, pollution and climate change would still leave at least 57% of threatened species (4,428 species) at risk of going extinct.
- This research shows that **we can't stop species from going extinct just by protecting particular areas (landscapes) and addressing key threats**:Some species needs dedicated efforts to help them recover.
- It is critical therefore that conservations entities adopt specific and measurable goals on species conservation, and a clear commitment to implement the actions needed to achieve these.

Case study: *Karomia gigas*

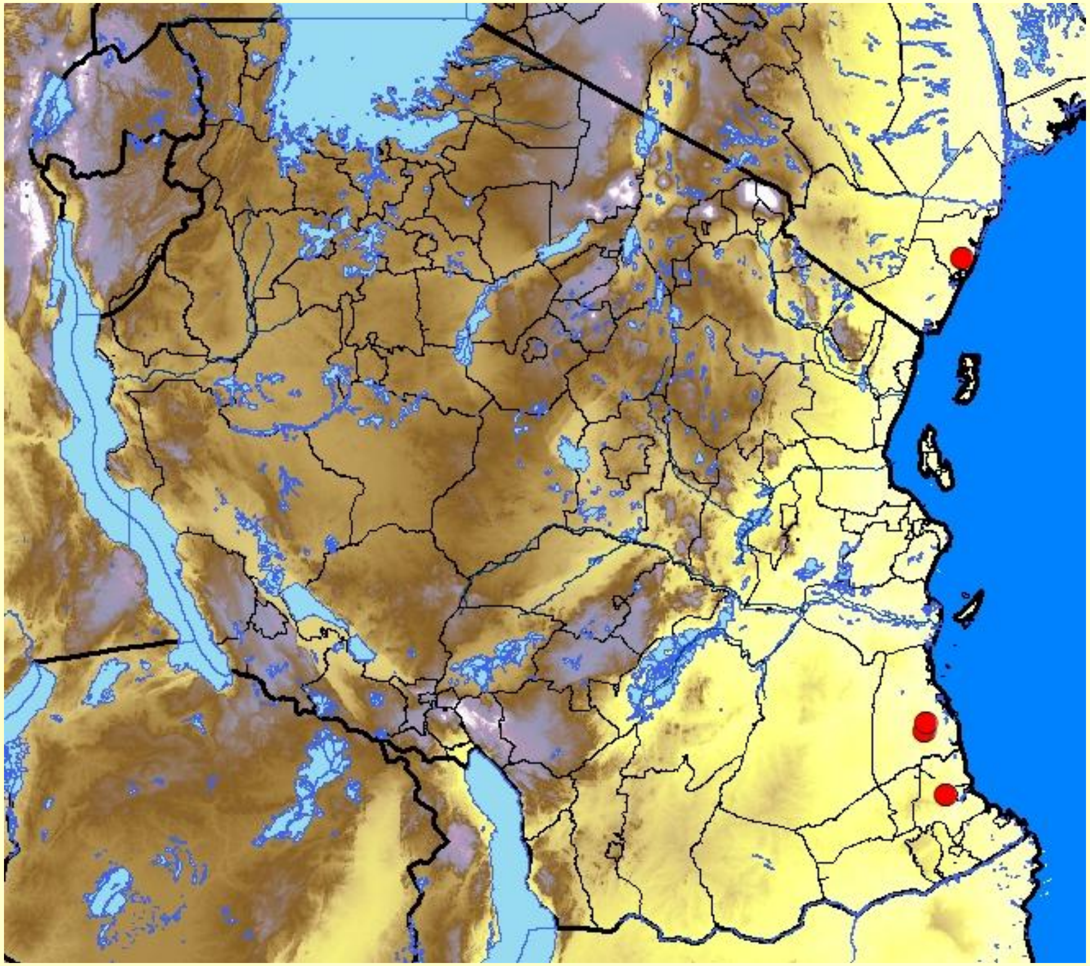
Karomia gigas is a tree species first discovered in a tiny fragment of sacred forest on the coast of Kenya in 1977. Only one tree and a sapling were seen, and on a later visit in 1985 it was found that they had been cut down.

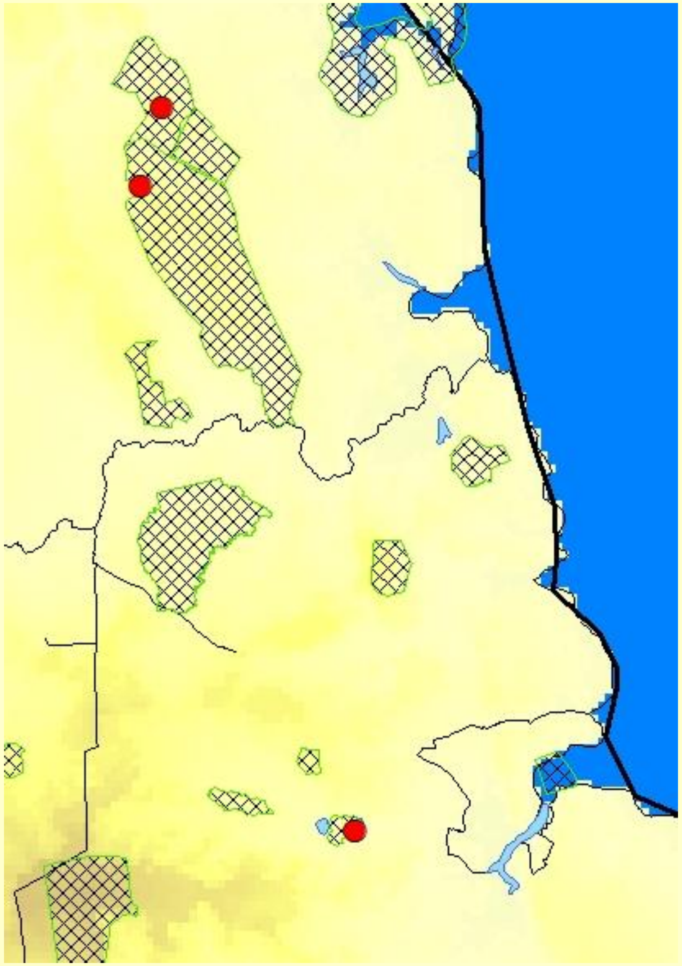


Case study: *Karomia gigas*

Then in 1993 a volunteer for Frontier Tanzania found a single fruit of this species at the edge of Ngarama Forest in Tanzania about 380 miles to the south of the site in Kenya. In 2011 botanists from the University of Dar es Salaam, Tanzania, found 6 or 7 trees in Mitundumbea Forest, about 6 miles from the discovery of the single fruit, followed by its discovery in Litipo Forest Reserve, about 60 miles farther south.

Historical distribution of *Karomia gigas* in coastal Kenya and Tanzania (left) and current distribution in Tanzania (right)





Case study: *Karomia gigas*

After the only known tree and sapling of *Karomia gigas* were found to be cut down in 1985, the species was considered “Feared Extinct”, although not formally listed as such on the IUCN Red List. With its rediscovery in Tanzania the species is clearly not extinct, but population numbers are very low.

With only 19 individuals known from Mitundumbea and Litipo forests, 14 mature individuals and 5 juveniles, the species automatically qualifies as Critically Endangered on the Red List. This raises the question: What can we do to assure the survival of this species?

Case study: *Karomia gigas*

In October 2016, a group of researchers from Tanzania, the U.S.A., and the U.K. traveled to Mitundumbea Forest to observe the *K. gigas* subpopulation growing there.

Case study: *Karomia gigas*

Very dry conditions: fallen fruit with no viable seeds

Case study: *Karomia gigas*

In May 2017, the Tanzania Tree Seed Agency (TTSA) currently merged to into TFs made a seed collecting expedition to Mitundumbea and Litipo Forests, collecting a large number of mature fruit with seeds.

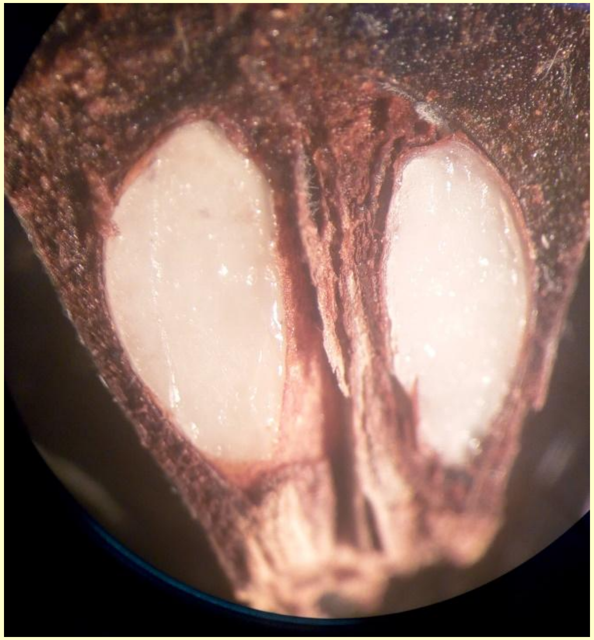
Case study: *Karomia gigas*

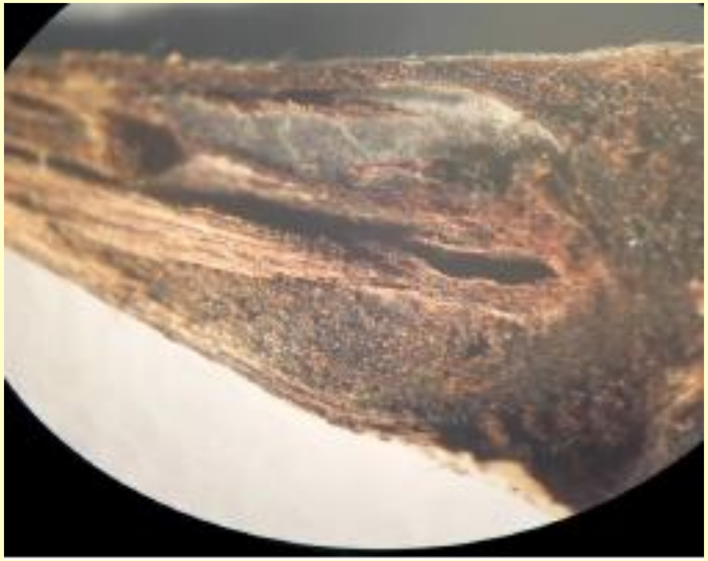
Case study: *Karomia gigas*

Eperties conducted preliminary examination to distinguish potentially viable seed from seed damaged by fungal attack.

Case study: *Karomia gigas*

Potentially viable seed (upper and lower left) and seed damaged by fungal attack (lower right)







Case study: *Karomia gigas*

Seeds were sown in various growth media in two different sites in Tanzania; however, despite all efforts only two seeds germinated and neither of those survived to become a healthy seedling.

Case study: *Karomia gigas*

At this point all parties decided that another approach was needed. In December 2017 an agreement was signed between TTSA and MBG to allow export of seeds from Tanzania for propagation in St. Louis; in May-June 2018 TTSA conducted another seed collecting expedition to Mitundumbea and Litipo Forests; and in September 2018, more than 6000 fruits each containing 4 seeds arrived at the MBG Horticulture Division.

Case study: *Karomia gigas*

Three horticulturists worked for 19 hours to open the fruits and extract the seeds.

Case study: *Karomia gigas*

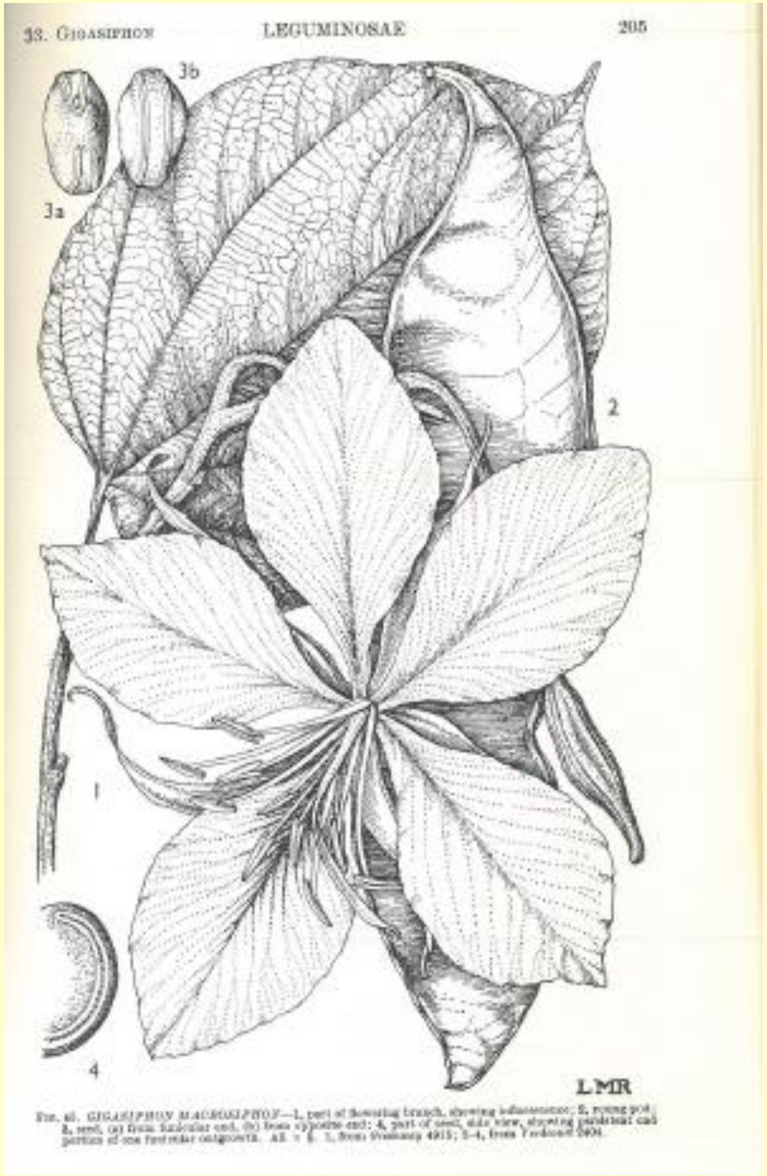
From more than 24,000 seeds, only 133 appeared that they might be viable.

Case study: *Karomia gigas*

The seeds were treated with a fungicide, germinated on paper towels, and eventually planted in pots, resulting in 30 healthy seedlings, the first known successful propagation of *K. gigas.*

Case study: *Gigasiphon macrosiphon*

Gigasiphon macrosiphon is a tree species in the Fabaceae (legume family) with spectacular yellow and white flowers and large, flat bean-like pods.

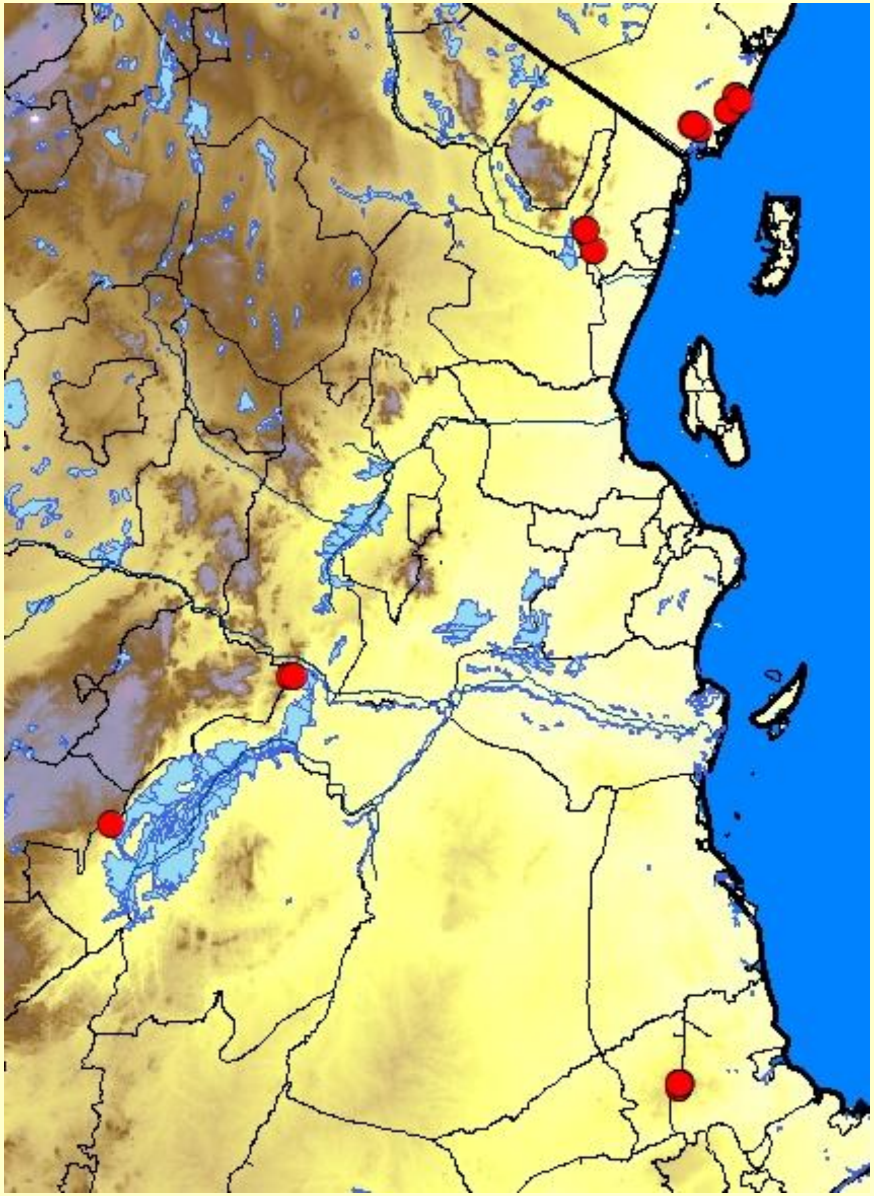


Case study: *Gigasiphon macrosiphon*

Flower, pods, seeds

Case study: *Gigasiphon macrosiphon*

G. macrosiphon is known from a number of localities in coastal Kenya and more inland sites from Tanzania, but is nowhere common. The seedlings are much eaten by a number of animals, especially forest antelope and feral pigs.



Case study: *Gigasiphon macrosiphon*

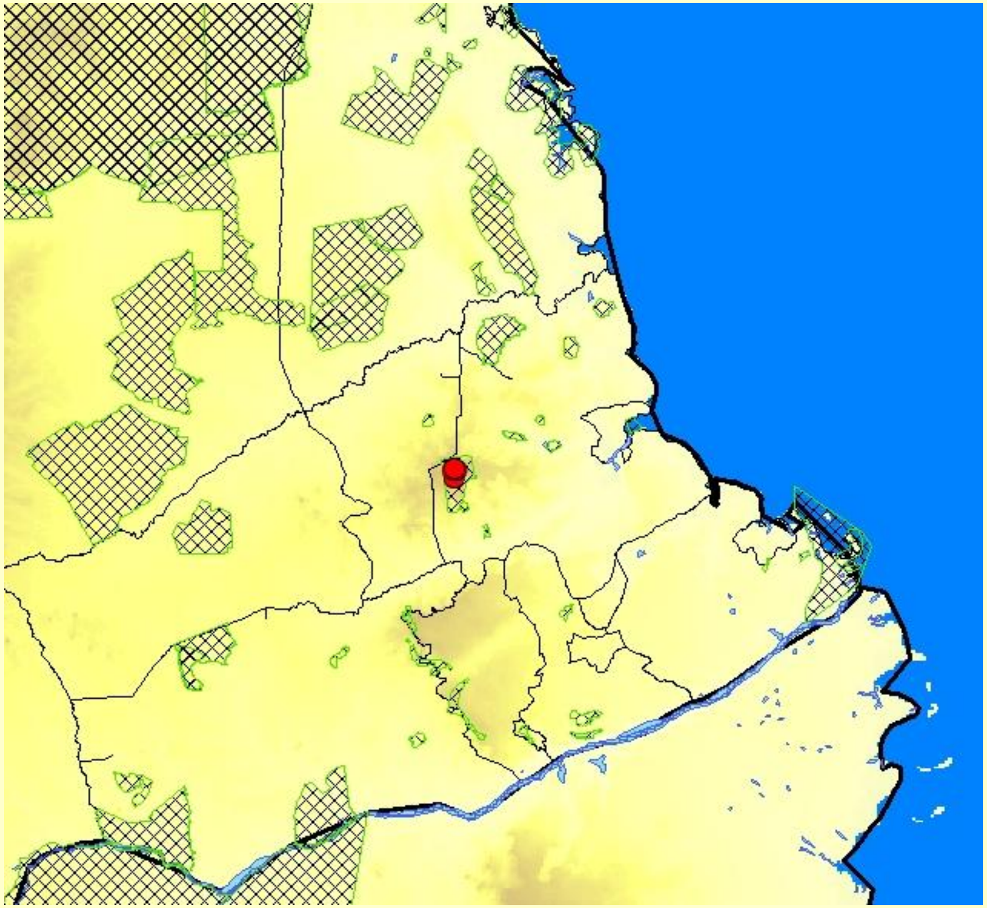
Because of severe seedling predation, very few juveniles of *G. macrosiphon* survive and the number of mature individuals at any given site is very low. Members of the Eastern African Plant Red List Authority have visited all 7 sites (3 in Kenya, 4 in Tanzania) and have counted only 38 mature individuals in the wild, automatically qualifying the species as Critically Endangered. As in the case of *Karomia gigas*, the question is now: What can we do to assure the survival of this species?

Case study: *Gigasiphon macrosiphon*

Base Titanium Ltd. has established a tree nursery near its Kwale Mine in coastal Kenya and has now planted over 1400 individuals of *G. macrosiphon*, representing most of the genetic diversity of the Kenyan subpopulations. Saplings begin to flower at 8-10 years of age.

Case study: *Gigasiphon macrosiphon*

In 2012 the Tanzania Forest Conservation Group rediscovered the southernmost subpopulation of *G. macrosiphon*, in the Rondo Nature Reserve, from where it had not been collected since 1951. In October 2018 the Tanzania Tree Seed Agency (TTSA) surveyed the subpopulation and collected seed for propagation.



Case study: *Gigasiphon macrosiphon*

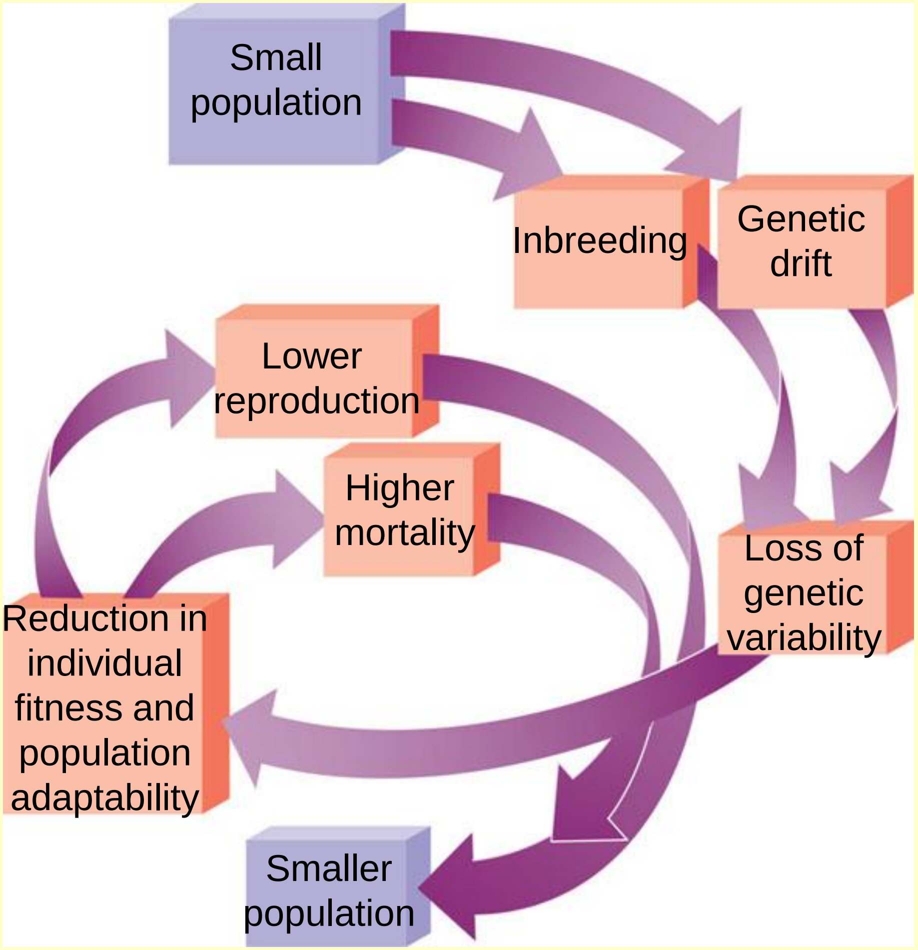
Seedlings grew readily from the collected seed and have been ceremonially planted at the TTSA Seed Production Station in Morogoro. Seedlings representing the genetic diversity of other Tanzanian subpopulations would be highly desirable.

Where do we go from here?

The case studies above address only two of the 314 threatened tree species in Tanzania, but they provide a framework on which to build a program to save many other species from extinction. Some elements of such a program are:

- Identification of recovery sites for to establish tree gene bank repositories and recovery plans partners;
- Expand seed collection, propagation efforts and ensure management plans include species specific conservation actions for Endangered and Vulnerable as well as rare, endemic or small population tree species

- **<u>Small – Population Approach</u>**
  - All small populations are considered endangered
  - Prone to an extinction vortex
  - Loss of genetic variation → susceptible to genetic drift



- **Declining – Population Approach**
  - Identify declining populations before they become small populations
  - Alter environmental factors until the population rebounds

Population & Species level conservation

- **Biodiversity hot spot**: small area with lots of endemic spp, many threatened or endagered
- **Endemic species**: species found nowhere else
- **Endangered species**: organism “in danger of extinction”
- **Threatened species**: likely to become endangered in the foreseeable future

Endangered species

(recently encountered in the field)

Acridocarpus alopecurus var. *machaeopterus*

Measures to save the situation

- Two approaches: *In-situ* and *Ex-situ* conservation
- *In-situ* conservation
- Upgrade the conservation status of resource areas Eg. UMNP, Kitulo National Park
- Increase connectivity of fragments eg. Derema EUM
- Restoration of degraded habitats
- Provide alternatives to local communities (fuelwood, Building materials, source of income etc)
- Joint Forest Management
- Improve livestocks d

Measures to save the situation

- *Ex-situ*
- Use of botanical gardens –refuge for endangered species

- Seedbanks eg the ongoing Millennium Seed Bank Project

- Application of biotechnology eg. Use of tissue culture techniques

Note: these are temporary measures

Need and Importance of Guidelines for seed collection

- **Facts**
- Tanzanias flora is very diverse....est. 12,000 vascular plants out of 330,000 globally

- Importance of the flora for the current and future generations can not be overemphasized...

- Threats to the flora are ever increasing....

Measures to save the situation

- From in situ and ex situ species recovery programmes, to the establishment of protected areas, to capacity building, conservation action can take many forms.
- *Ex-situ*
- Use of botanical gardens –refuge for endangered species
- Seedbanks eg the ongoing Millennium Seed Bank Project
- Application of biotechnology eg. Use of tissue culture techniques

Note: these are temporary measures

Forest Management Plans for natural forests

- Before any forestry activities can take place, a forest management plan must be in place.
- No Forest Management Planning Manual that provides the direction for preparing a plan.
- Plans does not include management at the stand, multi-stand, and meso-landscape scales on species composition, pattern , structure , and management of site-specific habitats to maintaining ecological functions including habitat suitability and productive capacity in standing waters (lakes and ponds), flowing waters (rivers and streams), special habitat which features groundwater recharge areas associated with bird nest sites, non-woody plants, invertebrates, amphibians, reptiles and mammals.
- No requirement to develop a species-specific recovery strategy or a management plans for threatened floras to laverage species at risk.

Things to consider when preparing recovery actions/objectives

ANSWER THE FOLLOWING QUESTIONS

- ❑ What are the ISSUES we need to talk about?
- ❑ How does each affect threatened trees or their conservation in that site?
- ❑ What causes them?
- ❑ How much do we know about them?
- ❑ What more do we need to know before we can take effective action?

ALSO WRITE

- ❑ **Species Description:** Provide a *brief* physical description of the species in plain language.
- ❑ **Species Population and Distribution:** Briefly summarize the best available knowledge on global and regional or country distribution and abundance of the species, and report on the level of confidence in this information (global and regional or country **distribution and abundance and estimate %)**
- ❑ **Habitat and Biological Needs of the Species: D**escribes the habitat that the species depends on directly or indirectly to carry out its life-cycle processes (i.e., a biological need or requirement of the species necessary for its survival.
- ❑ **Features:** Aspects of the habitat that have the functional capacity to support a life process

Things to consider when preparing recovery actions/objectives

Characteristics of Recovery/Management Objectives Must be (SMART):

Specific: clearly and concisely state what needs to be achieved in terms of population size/number, species distribution, or threat reduction to reach the recovery goal.

Measurable: present objectives either quantitatively or qualitatively in a way that makes it possible to know when the outcome has been reached; quantify the amount of change to be achieved.

Achievable: be realistic given known limitations and threats.

Relevant, results-focused, realistic: relate objectives to recovery goals and the needs of the species. Objectives should be biologically and technically realistic.

Time-bound: specify a time target by which the objective is to be reached (5 years is a common short-term timeframe).

Threats to Biodiversity

- Human Activity
  - **Habitat Destruction**
    - Agriculture
    - Urban development
    - Forestry
    - Mining
    - Pollution
    - Has caused 73% of extinct or endangered species

Threats to Biodiversity

- **<u>Introduction of non-native species</u>**
  - Invasive
  - Exotic
  - Transplanted species
  - Compete with or prey upon native species
  - Responsible for about 40% of all extinctions

Threats to Biodiversity

- **Extinction of an important species**
  - Keystone Species
  - Founder
  - Disrupts the interactions between species an then other species become threatened

Threats to Biodiversity

- Levels
  - **Population** - Loss of genetic diversity within a population lessens the species adaptive potential
    - Natural Selection
  - **Community** – Loss of species richness → less stability
    - **Endangered Species** – susceptible to extinction
    - **Threatened Species** – likely to become endangered
  - **Ecosystem** – Loss of an ecosystem → affects entire biosphere