



**AL-FARABI KAZAKH NATIONAL UNIVERSITY
FACULTY OF BIOLOGY AND BIOTECHNOLOGY
DEPARTMENT OF BOTANY AND AGROECOLOGY**



LECTURE 2
Overview of Endemic and Relict Plants of the Steppe Zone

**Lecturer: Doctor of Biological Sciences, Professor
Kurmanbayeva M.S.**
**Course title: Conservation of Rare and Endangered Plant
Species**

LESSON PLAN (50 MINUTES)

1. Introduction (5 minutes)

- Greeting and announcement of the topic and goals.
- Short discussion: what is a steppe ecosystem?
- Geographic overview of the steppe zone of kazakhstan (northern, central, and western parts).

2. Main part (35 minutes)

A) key concepts (10 min)

- Definition and significance of endemic and relict species.
- Difference between endemic, relict, and widespread species.
- Role of endemic plants in regional biodiversity and evolution.

B) natural conditions of the steppe zone (25 min)

- Climate: continental, semi-arid.
- Soils: chernozem, chestnut, and saline soils.
- Vegetation characteristics: dominance of grasses and herbaceous plants.

3. Conclusion (10 minutes)

- Summary of main ideas.
- Discussion question: “why are endemic and relict plants valuable for the steppe ecosystem?”
- Short quiz or oral review (name 2 endemic and 2 relict species).
- **Homework:** prepare a short presentation on one endemic steppe plant of kazakhstan.





What is the Steppe Zone?

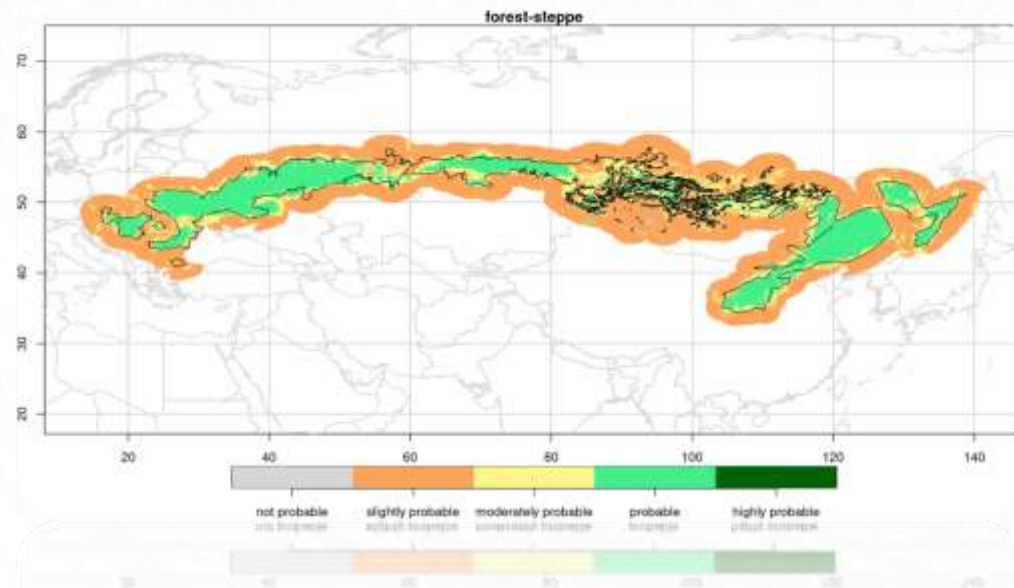
The steppe zone encompasses vast temperate grasslands stretching over 8,000 kilometres across Eurasia. These semi-arid landscapes are characterised by distinctive climate patterns: hot, dry summers and intensely cold winters with limited precipitation averaging just 25–30 centimetres annually. This challenging environment has shaped unique vegetation communities over millennia.

Dominant Grasses

Bromus, *Festuca*, and *Stipa* species form the structural foundation, providing resilience against extreme conditions.

Associated Flora

Scattered shrubs and low forbs complement grasses, creating diverse microhabitats adapted to drought and temperature extremes.



Biodiversity Significance

Home to endemic and relict plant species reflecting ancient evolutionary histories and ecological adaptation strategies.

Defining Endemic and Relict Plants

Endemic Plants

Species that are native to and restricted exclusively to a specific geographic area within the steppe. Their limited range makes them particularly vulnerable to localised disturbances and habitat loss. Endemics represent successful evolutionary adaptations to particular steppe microclimates and soil conditions.

Both groups are crucial for understanding steppe biodiversity, ecosystem resilience, and the dynamic evolutionary processes shaping these remarkable landscapes.

Relict Plants

Ancient plant survivors from earlier ecological periods, persisting in isolated steppe refugia across vast time scales. Relicts often represent remnants of flora that dominated different climate conditions, now retreated to specific suitable zones. Their presence illuminates deep evolutionary history.



Adaptations of Steppe Endemic and Relict Plants

Surviving in the steppe's extreme conditions demands remarkable physiological and morphological innovations. These plants have evolved sophisticated strategies across multiple levels to persist where few others can thrive.

Morphological Adaptations

Hairy or waxy leaf surfaces (characteristic of sagebrush and tall buckwheat) reduce water loss through transpiration and reflect intense sunlight, protecting tissues from scorching.

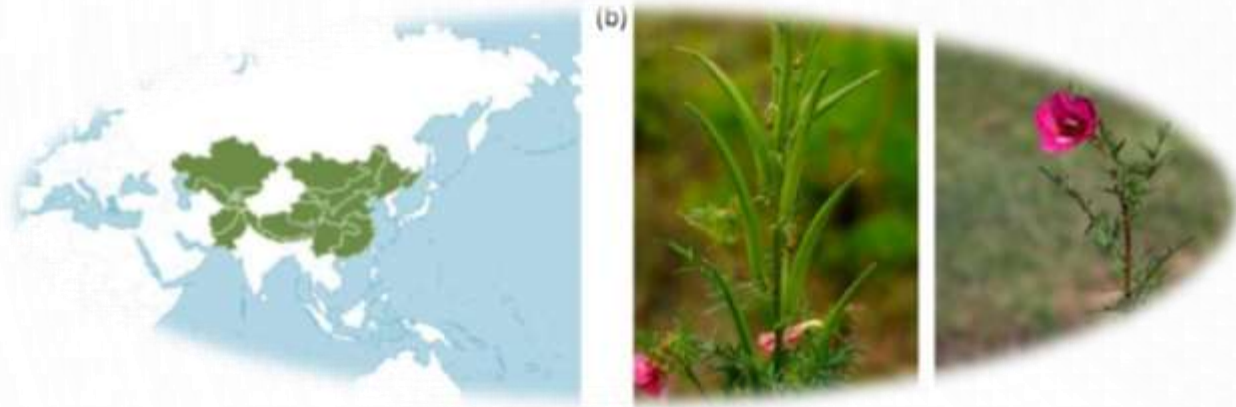
Phenological Adaptations

Life cycles precisely timed to exploit brief moist periods. Annuals germinate rapidly following rains to complete their lifecycle quickly, whilst perennials remain dormant underground during extended droughts, conserving precious resources.

Root System Innovations

Extensive and deeply penetrating root systems (such as those in bluebunch wheatgrass) access scarce groundwater and provide mechanical anchorage against wind exposure, essential for survival in harsh steppe conditions.

Incarvillea semiretschenskia P.Ya. Gontsch : A Rare Relict Endemic



This xerophytic dwarf semishrub represents a remarkable survival story, endemic exclusively to the Shu-Ile low mountains of Kazakhstan. Distinctive bright pink tubular flowers distinguish this species, which typically grows to approximately 70 centimetres in height.

Conservation Status: Listed in Kazakhstan's Red Data Book due to severely restricted and fragmented distribution patterns. Primary threats include habitat loss from mining activities, infrastructure development, and human disturbance.



Despite multiple rediscoveries highlighting its persistence, this species remains critically endangered—underscoring the acute challenges faced in monitoring and protecting isolated relict populations across remote mountain refugia.



***Tetraena mongolica* Maxim**

Climate Change and Steppe Relict Plants

Climate change presents complex, sometimes counterintuitive challenges for steppe vegetation. Relict plants show considerably greater resilience than typical desert and steppe shrubs, owing to their long evolutionary histories and broad adaptive capacities honed across millennia of environmental fluctuation.

Relict Resilience

Desert-steppe studies reveal stable or expanding suitable habitats for relict species like *Tetraena mongolica*, suggesting evolutionary flexibility.

Vulnerable Species

Typical desert and steppe shrubs face habitat reduction and dramatic range shifts, dramatically increasing extinction risk for species with narrower ecological tolerances.



***Incarvillea sinensis* Lam**

Conservation Challenges in the Steppe Zone

Protecting steppe endemic and relict plants requires addressing interconnected threats operating across multiple scales. Modern land-use pressures and fragmentation have created an urgent conservation imperative for these irreplaceable botanical resources.

1

Habitat Loss and Conversion

Agriculture, overgrazing, and industrial development destroy native steppe communities, fragmenting populations into isolated remnants with diminished genetic viability and reduced adaptive potential.

2

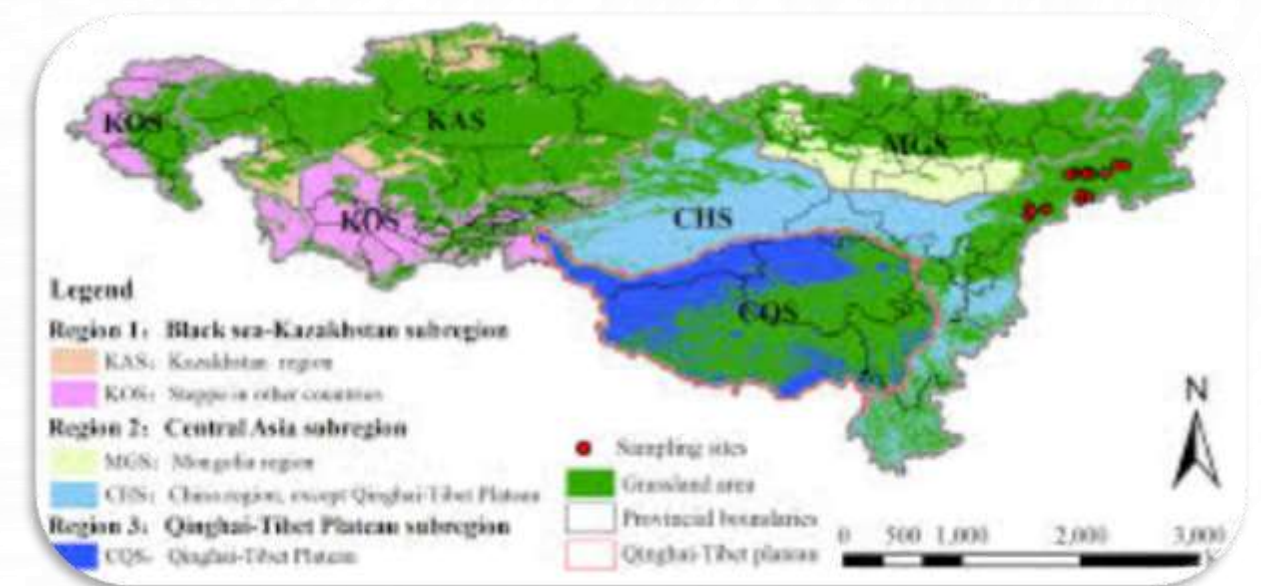
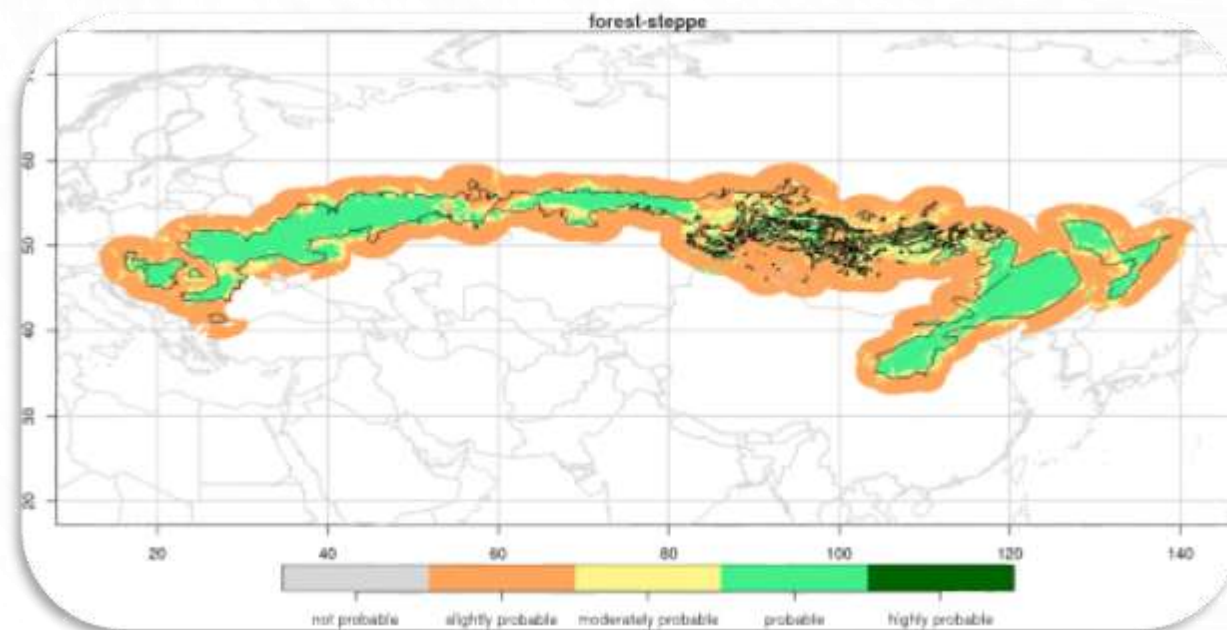
Population Fragmentation

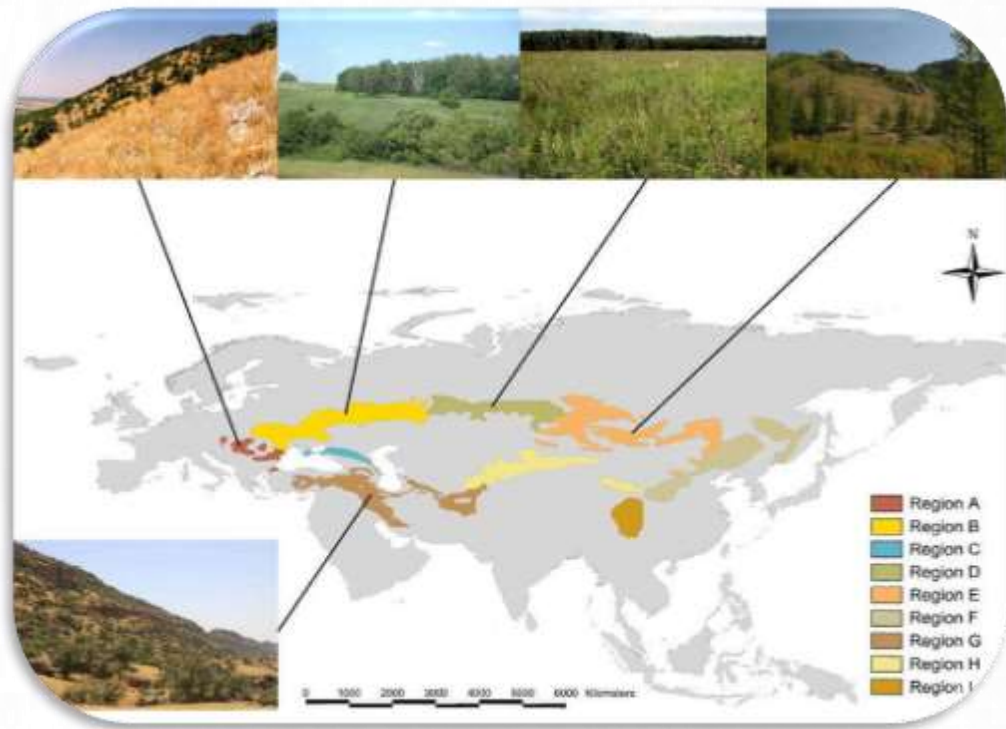
Isolation prevents gene flow between populations, reducing genetic diversity and capacity for adaptation to environmental changes, threatening long-term species persistence.

3

Balancing Conservation and Use

Effective protection requires integrated strategies combining controlled grazing, selective disturbance regimes, and strategic burning to maintain steppe structure whilst permitting sustainable human land use.





The Kungur Forest–Steppe: A Biodiversity Hotspot

The Kungur forest-steppe in the Perm Krai of Russia represents Europe's northernmost forest-steppe ecosystem, harbouring exceptional botanical diversity shaped by complex interactions between boreal, nemoral, and steppe species over millennia.



957

Total Plant Species

Higher vascular plant
species documented

31

Endemic Species

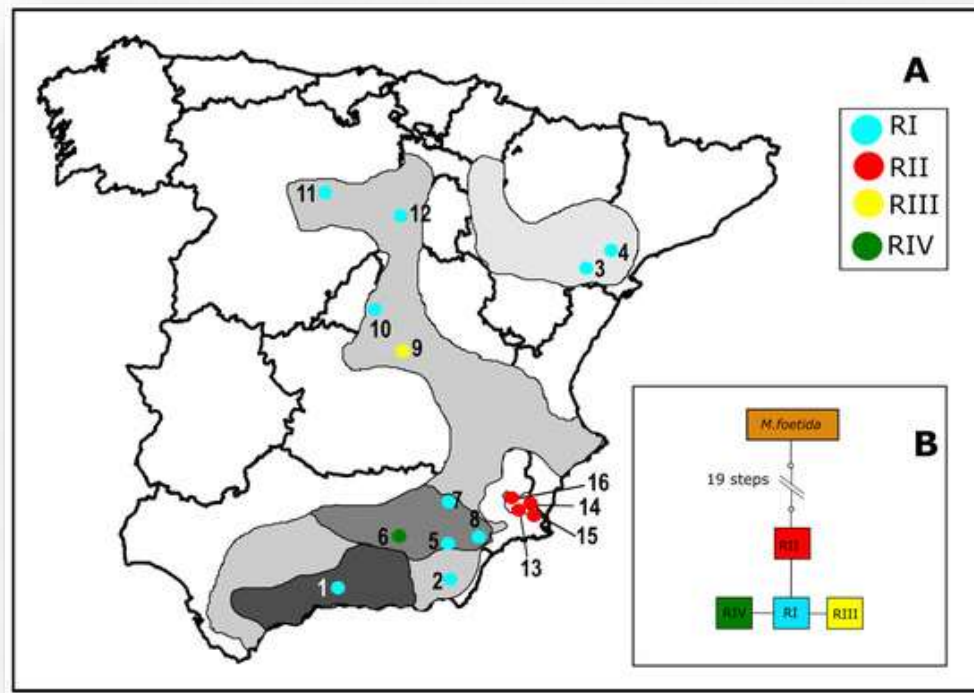
Plants restricted to this
unique ecosystem

17

Relict Taxa

Ancient survivors from
earlier periods

This intricate mosaic reflects millennia of natural and anthropogenic influences. Contemporary conservation emphasises maintaining disturbance regimes through selective logging, controlled grazing, and managed burning—ecological processes essential for preserving steppe assemblages within this biodiverse landscape.



Phylogeography and Genetic Diversity of Steppe Plants

Steppe endemic and relict plants carry unique genetic signatures shaped by ancient biogeographic processes. During glacial maxima, populations survived in isolated refugia scattered across the steppe zone, establishing distinct evolutionary lineages now recognised through molecular phylogeographic analysis.

Genetic Distinctiveness

Populations throughout Eastern Central Europe display moderate-to-high genetic distinctiveness, reflecting independent evolutionary trajectories and local adaptation patterns accumulated over thousands of years.

Conservation Imperative

Loss of local populations risks permanent extinction of unique evolutionary lineages. Protecting entire species ranges—not isolated populations—preserves the full spectrum of genetic variation essential for long-term persistence.

Protecting the Steppe's Botanical Heritage

Endemic and relict plants of the steppe zone are living links connecting us to the region's ancient past, embodying evolutionary wisdom accumulated across millennia of environmental change. These remarkable species represent irreplaceable repositories of genetic and ecological knowledge.

1

Understanding Adaptations

Detailed ecological and physiological research illuminates how these species survive extreme conditions, knowledge applicable to broader conservation and climate resilience strategies.

2

Monitoring Climate Impacts

Long-term population surveys and phenological monitoring track responses to climate change, enabling proactive management and early intervention for threatened populations.

3

Implementing Informed Conservation

Urgent action combining protected area designation, habitat restoration, genetic resource preservation, and sustainable land management ensures survival of these botanical treasures and the vast steppe ecosystems they sustain.