

Genomic solutions to sustainable development

**Week 5 — Conservation &
Ancient Genomics**

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Part I: Conservation Genomics

MOUNTAIN GORILLAS



AMUR LEOPARD



YANGTZE FINLESS PORPOISE



JAVAN RHINOS





SOUTH CHINA TIGER



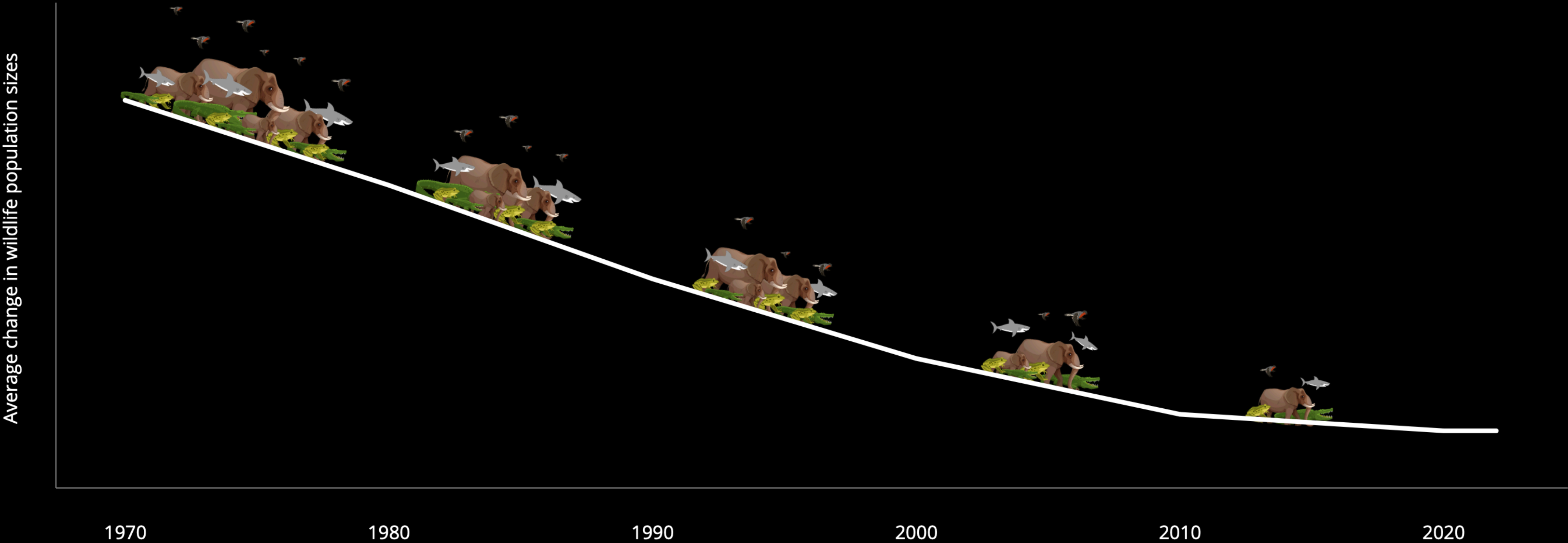
Extinct in the wild

200 individuals in zoos

NATURE IS DISAPPEARING: THE AVERAGE SIZE OF WILDLIFE POPULATIONS HAS FALLEN BY A STAGGERING 73%



The Living Planet Report 2024 highlights the average change in observed population sizes of 5,495 vertebrate species. It shows a decline of 73% between 1970 and 2020.



International Union for Conservation of Nature and Natural Resources (IUCN RedList)

- **Global conservation status:** IUCN Red List is the most comprehensive source for assessing extinction risk of species worldwide (LC=least concerned to EX=extinct)
- **Assessment criteria:** population size, rate of decline, geographic range, and threats
- **Biodiversity indicator:** barometer of biodiversity health, which helps scientists, governments, and conservation managers to track trends and define priorities
- **Threats to species:** major threats include habitat destruction, climate change, overexploitation, pollution, and invasive species (need for sustainable practice)
- **Action & Policy:** support of global conservation policies such as the “Convention on International Trade in Endangered Species of Wild Fauna and Flora”, “Convention on Biological Diversity”, and national initiatives

Status and Trends in Global Diversity

IUCN Red List Quadrennial Report



Over 45,000 species are threatened from extinction

EW - Extinct in the Wild
 CR - Critically Endangered
 EN - Endangered
 VU - Vulnerable
 NT - Near Threatened
 DD - Data Deficient
 LC - Least Concern.

Convention on Biological Diversity

International instrument for sustainable development



The **Convention on Biological Diversity (CBD)** is the international legal instrument for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources".



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GLOBAL BIODIVERSITY FRAMEWORK

4 goals for 2050 and 23 targets for 2030

Convention on Biological Diversity

International instrument for sustainable development



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GLOBAL BIODIVERSITY FRAMEWORK

4 goals for 2050 and 23 targets for 2030

GOAL A

Protect and Restore

The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050;

Human induced extinction of known threatened species is halted, and, by 2050, the extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels;

The genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential.

Biodiversity and genetic diversity

■ Biodiversity

- ecosystem diversity (ie, habitats, communities)
- species diversity (ie, species in an ecosystem)
- genetic diversity (ie, genetic variation within a species)

■ Genetic diversity

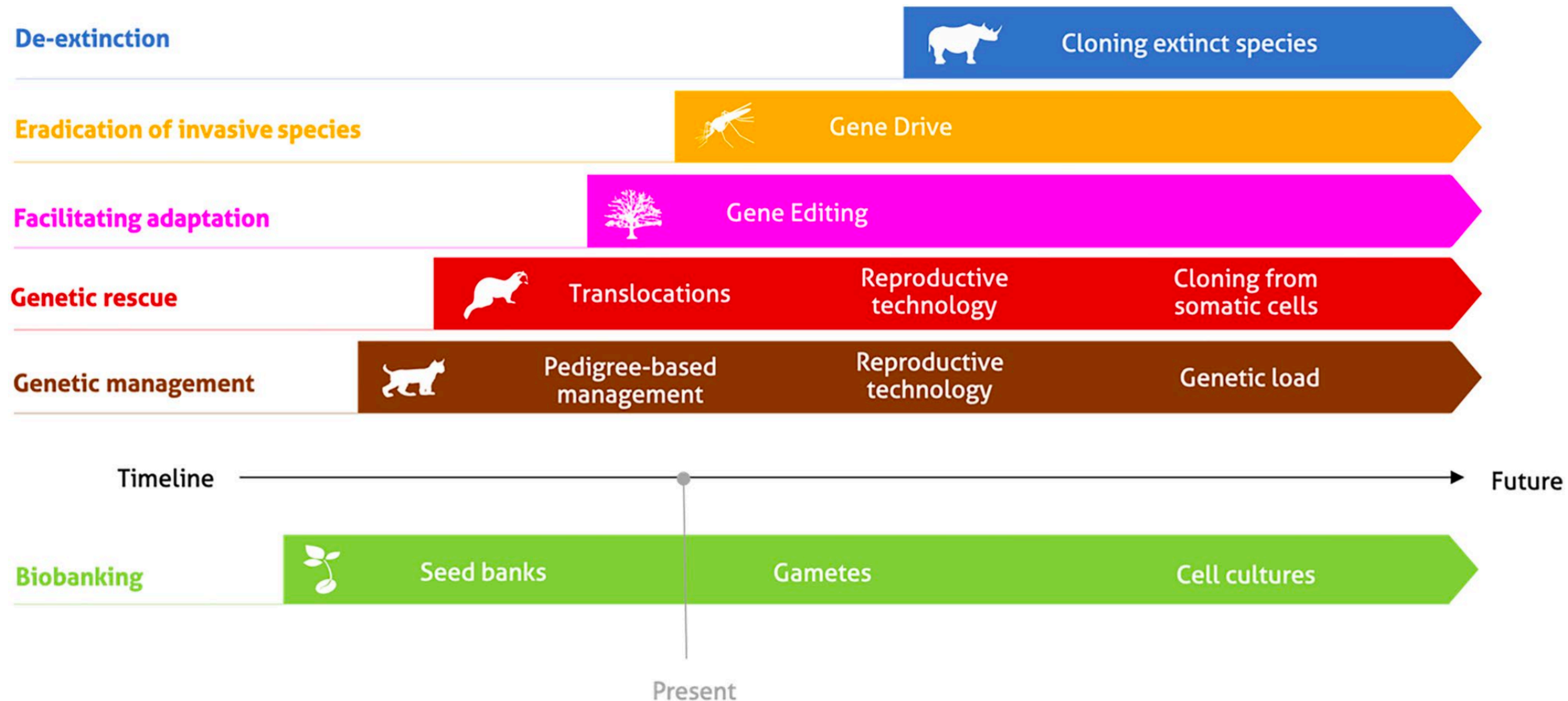
- key to maintain adaptive potential for future change
- key for fitness of individuals to ensure survival
- allelic variation at critical genes (eg, immune genes)

Genetics in conservation management

- Population diversity and inbreeding
- Adaptive potential due to climate change
- Genetic status of captive or translocated populations
- Genetic divergence of populations
- Differences/similarities between source and receiving populations
- Reproductive contribution of translocated populations
- Founder populations
- Reproductive skew

Genomics in conservation management

- Genomics provides novel technologies to enhance our understanding of global biodiversity
- Wide range of applications: management, policy, ecology, translocations, evolutionary biology



Segelbacher et al. Conservation Genetics (2022) 23:217–242

Genetic data, targets, and action plans towards zero extinctions: a blueprint from the Australian government



The **2022–2032 Threatened Species Action Plan** outlines Australia’s commitment to preventing extinctions, improving habitat conditions, and strengthening conservation efforts for priority threatened species through science-based actions, collaboration, and long-term monitoring.

Genetic data, targets, and action plans towards zero extinctions: a blueprint from the Australian government

OPTIMIZE TARGETS

Prevent new extinctions

- Genetic monitoring helps detect population declines early and guide urgent conservation actions.
- Identifies genetically distinct populations that may require specific protection.

Improve population resilience

- Genetic assessments identify inbreeding risks and inform conservation breeding programs.
- Helps maintain genetic diversity to improve species' adaptability to environmental changes.

Maintain or improve the condition of habitat for threatened species

- Genetic data informs habitat connectivity strategies to prevent population fragmentation.
- Determine which habitats support genetically diverse populations.

mountain pygmy possum



Nat Commun 8, 1071 (2017)

Genetic data, targets, and action plans towards zero extinctions: a blueprint from the Australian government

OPTIMIZE TARGETS

Improve the trajectory of threatened species

- Genetic monitoring helps assess population recovery and genetic health over time.
- Identifies individuals best suited for reintroductions to ensure the survival of a species.

Manage emerging threats and climate change impacts

- Genetic research helps identify species with heat or drought-resistant traits.
- Assists in predicting which species may struggle to adapt to climate change.

Strengthen conservation planning and management

- Genetic studies improve conservation action plans by recognizing unique or at-risk populations.
- Define Evolutionarily Significant Units to target the most important genetic groups.

mountain pygmy possum



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OPTIMISE ACTION PLANS

Species translocations and reintroductions

Genetic analysis ensures reintroduced individuals are diverse and suited to local conditions.

Captive breeding and genetic rescue

Genetic tools guide breeding programs to prevent inbreeding and maintain genetic diversity.

Monitoring population genetics

Helps detect loss of genetic diversity, hybridization risks, and adaptation potential.

tasmanian devil



Genetic data, targets, and action plans towards zero extinctions: a blueprint from the Australian government

OPTIMISE ACTION PLANS

Detecting cryptic species

Genetic data helps identify species that look similar but are genetically distinct (improved conservation targets)

Disease resistance research

Identify genes and genetic variation linked to disease resistance.

Environmental DNA (eDNA) surveys

Track threatened species presence in ecosystems without direct observation.

kākāpō (New Zealand)

