Earth Observation Data Can Assist in Genetic Diversity Monitoring

Executive Summary: Genetic diversity monitoring and protection is fundamental to prevent harmful biodiversity loss. The Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework contains global commitments to monitor and report on genetic diversity trends for all wild species. Implementation of these commitments is often precluded by the absence of DNA based data, consequently proxy based monitoring of genetic indicators is now also used. Earth observation (EO) data can be used to support the calculation of genetic indicators. Particularly for species located in inaccessible regions, those without historical data, or in regions with limited financial support and capacity. Importantly, with EO data we can rapidly expedite and scale-up species genetic diversity monitoring, create real time monitoring systems, and prioritize biodiversity conservation efforts.

Key Terms

Genetic diversity (or genetic variation) consists of within species differences in DNA sequences, as well as differences in the distribution of genes among populations. Genetic diversity is fundamental to population and species health, and long term survival and resilience of species.

Proxy based monitoring has been proposed to support monitoring of genetic diversity in regions where DNA based methods are not possible (e.g., due to cost, time, technology, safety, accessibility barriers). Proxy-based indicators include:

(a) **Populations Maintained (PM):** the proportion of distinct populations maintained within a species relative to a baseline (e.g., 2011-2020). Distinct populations contain unique genetic diversity, often this is tied to specific geographical regions or habitats. Population loss is associated with irreversible genetic diversity extinction.

(b) **Ne > 500:** reflects the risk of genetic diversity loss within populations. Below threshold values (Ne<500) indicate ongoing genetic erosion that will reduce adaptive capacity and reduce population health. To obtain and Ne of 500 the number of individuals often must be c. 10 times as many, i.e. 5000.

Earth observation (EO) data is acquired from satellites and collected remotely, without a person in the target location (ex situ).

Brief Summary

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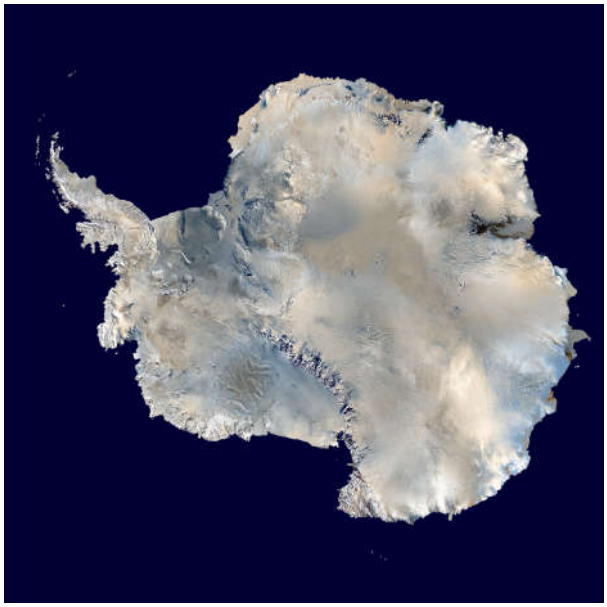

Operational uses of EO data	Uses in genetic diversity monitoring	Non-operational uses of EO
1. **Species range and habitat mapping** *Accuracy increases with prior knowledge and in terrestrial habitats*	**Inference of census size** *from dispersal distance or occupation density data, allows* **approximation of Ne**	Cannot directly measure effective or census population sizes (Ne or Nc)
2. **Estimate population size and number** *Accuracy increases when combined with observational data*	*Inferred population locations can be combined with other data (e.g. biogeographical, traditional knowledge) to* **infer population distinctiveness** *or support the design of comprehensive DNA studies to confirm this*	Cannot independently identify genetically distinct population
3. **Detect habitat and ecosystem change** *Requires a baseline and continued monitoring*	*Develop localised ALERT EO based systems to support genetic diversity* **protection in real time** *and* **monitor PM or inferred Ne over time**	Cannot detect all on the ground threats to individuals (e.g., poaching)
4. **Map variation or change in species visible from space** *e.g., trait variation, migration, breeding activities, species interactions*	**Not currently fully operational.**	Cannot directly estimate genetic diversity