

Implementation of the Far Eastern Leopard Population Conservation and Restoration Programme

A New Proactive Paradigm



Marcello Zorzi



Leopard Land National Park, Primorsky Krai, Russia



2026

A Unique Historical Moment

Technology is changing fast. We are only starting to understand how it can help society. And how it can help us in conservation.



Advanced Monitoring System

Leopard Land National Park already has an advanced monitoring system. A network of camera traps rare in conservation panorama.



Preliminary Analysis Model

With this idea, we built a preliminary analysis model. This model studies how tigers and leopards and in future we hope also other animals live together in the National Park, and also not just here.



Unique Database

For more than ten years, this system has helped the park to collect data. So park database is unique for its quantity, its quality, and its potential for analysis.



Surprising Results

The preliminary results are very interesting. They show that Far Eastern leopards and Siberian tigers have a special strategy to coexist. Data suggest an asymmetric coexistence strategy.



A sexually mediated plasticity that supports demographic stability in a shared landscape. We hope that our experience could be useful for the Big Cat Network.

The Program: From Past to Future

Today we don't want just updating the park management plan but also change our view to think the conservation actions.



Ten-Year Database

10+

Years of camera trap data

235

Monitoring stations

320+

Identified individuals

Until today, intact our analysis described the past.



Fragile Population

~130

Leopards – growing but fragile

~600

Tigers – increasing faster



Competitive pressure rising

Now, we would will try to predict the future.



Window of Opportunity

Federal Program

2026–2030



Mandate and deadline



Closing window

The Russian Federal Program gives us a mandate.

But it also gives us a deadline.

→ This program is our vision of the future.

Numbers Tell a Story of Tension

We have about 130 leopards. This is a success. In 2007, there were only about 30. But with a population of 130 leopards this is still the most endangered leopard subspecies in the world.



~130

Leopards

- ↑ From ~30 in 2007
- 🏆 Success story
- ⚠️ Still most endangered subspecies

⚖️ The Same Resources

- 🏠 Territory is the same. The space is the same.
- 🍴 The prey are the same.
- 🛤️ The paths are the same.



~600

Tigers

- ↑ Increasing faster than leopards
- 📈 Asymmetric growth
- 👑 Dominates where they coexist

⚠️ The Problem

This could be a problem for leopards. In fact where they live together, the tiger dominates.

📊 So with our model we try to measure these problems.

The Discovery: Coexistence is in Time, Not Space

Our preliminary results tell us something of really surprising.



Temporal Partitioning

Leopards and tigers live together but in different times.

-1.78h

Activity shift

Male leopards move their main activity of 1/2 hours later in presence of male tigers.



Key Insight

So, coexistence is a partition of time.

Not spatial separation

Robust Signal

- ✓ Stable signal across dataset
- ✓ Resists false positive correction
- ✓ Highly significant ($p < 0.001$)

⚠ Critical Warning

This is the strongest mechanism we have identified, and it tells us that if time is running out, the system is collapsing before the numbers even show it.

→ Coexistence in TIME, not in space — the most robust and replicable mechanism

The Hidden Thermometer: Females in the South

But there is an even more interesting signal.



The Signal

The female leopards reduce their range of activity in presence of a tiger female.



We suppose that it happen because leopard female move less to protect their cubs from meeting female tigers.



"Stay and Defend Strategy"

It's a real behavioral cost with real demographic consequences.



Move less



Protect cubs



Bayesian Confirmation

96.8%

Bayesian Probability

This effect is real. It is not noise. It is not a coincidence.



The Critical Threshold

Current: 6.4h

Critical: 6h

85% of critical threshold reached

Below that limit, the cost becomes reproductive failure.



The behavioral signal precedes the demographic one. We must act before the census shows a decline.



The Paradigm Shift: Five Integrated Pillars

This change of prospective requires a new integrated approach. Our program approach has five pillar, links in the same chain and not separate areas.



Species Monitoring

- Camera traps
- eDNA
- Genetics



Habitat & Ecosystem

- Vegetation
- Climate
- Biodiversity



Human Impact

- Tourism
- Conflicts
- Roads



Behavioral Science

- GLMM
- GAMM
- Bayesian Models



GA.IA Platform

- AI
- Alerts
- Reporting

Integration Flow

Each pillar feeds GA.IA. And GA.IA gives alerts and reports in real time.

Philosophy

We are not adding complexity. We are integrating what we already do.

→ From camera traps to GPS collars, from sensors to Bayesian models, all to support management decisions in the right time.

The Geography of Risk: Three Zones, Three Strategies

From our models we also see that the park is not uniform and it could not manage as one single block.



NORTH

Refuge

Female Activities

>10h

- ✓ Competition is more mitigate
- ✓ Stable population

Continue with what we are doing and just see and protect.



CENTER

Transition

Female Activities

-7h

- ⚠ Moderate competition
- 📈 Monitoring crucial

Intensify the monitoring and use the GPS collars.



SOUTH

Critical Zone

Female Activities

-6h

- ⚠ Too close to limit
- 🔥 High competition
- 🌡 Climate change impact

The system's thermometer. Immediate action required.

🔄 Climate Change Connection

Why in the South there is this situation? Probably because of several factors: but I think because here are stronger the impacts of global warming.

⚙ Adaptive Management

That's why we think that the management of the National Park must be adaptive and differentiated. We can no longer use uniform approaches.



GA.IA: From Collection to Decision

In the last period we are working on GA.IA. In our minds GA.IA must be the technological backbone of this program.



AI-Powered Analysis

Of course it does not replace a biologist. It does not replace a conservation expert. But it will improve their ability to see patterns that the human eye misses.



Distinguish species and individual animals in a camera trap



Process an acoustic signal and identifies the species in <1 min



Update the risk map of the all park in <1 hour



Multi-Level System

L1

Cameras, Audio, IoT, Hair, eDNA

L2

MegaDetector, BirdNET, YOLO11

L3

GLMM, CJS, Bayesian, SECR

L4

Alert & Reporting



Alert System

The real value is in the fourth level



Yellow Alert

<7h/day

Female active less than 7 hours → intensify monitoring



Red Alert

<6h/day

Below critical threshold → immediate intervention



Proactive Intervention

So the intervention will starts before the collapse and not after.



When GA.IA will fully operative we will have an advanced multi-level predictive system.



I do not think a similar system exists in any other protected area in the world today.



Why Now, Why Here

I will conclude with three considerations.

01

Scientific Proof

We have proof that coexistence is possible.

But we have also identified where and how this coexistence could break.



Asymmetric coexistence strategy confirmed

02

Action Window

The window for action is now as soon as possible, not 2030.

We cannot wait.



2026–2027: critical years

03

Exportable Model

What we are building here is a model that we can export.

We think GA.IA platform as a modular multilevel system so it can be shared and it could work in others areas and on other species.



Applicable to other big cats



Global Applicability

If we will have successful here, we invent a method. A method that can be applied everywhere.



Modular System

Tigers and leopards in India face the same challenge. If we can do it here, let's invent a method.



We have the technological tools to move from REACTIVE CONSERVATION to PROACTIVE CONSERVATION



Conservation is not a photograph. It is a living model.

There is no extinction that could not have been avoided,
if only we had known how to look in time.



Today we have
the tools



Today we have
the data



Today we have
the technology

Let's do it.

Marcello Zorzi

marcello.zorzi@hotmail.it

Dal'nevostochnykh Leopardov ANO · Leopard Land NP · Primorsky Krai