



# WildTrack Annual Report 2022-3

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A magnificent black rhino at dusk, in full attention, at the Kuzikus Wildlife Reserve Namibia.

WildTrack's innovative research and field techniques have helped protect black rhino in their strongholds of Zimbabwe and Namibia, and are now expanding into Botswana.

# Welcome, and thank you for joining us



Sky Alibhai & Zoe Jewell  
WildTrack co-founders

Providing data-driven conservation solutions is central to our work. Biodiversity is disappearing at unprecedented rates, and protecting it requires reliable data to inform on optimal conservation strategies.

Footprints are a vast, untapped repository of data that are constantly being renewed by the Earth's forces of wind and rain. The ground is a blank canvas being sketched each time animals move. Our award-winning footprint identification technology (FIT) informs us where species most need our help.

Here we report on the recent advances we've made to collect and process these data more efficiently, including our new WildTrackAI app, and our new AI platform.

As conservation biologists living in a time of extreme environmental change, we also have to be activists - communicating the need for societal change to tackle biodiversity loss. Our new website, focusing on participation, is another step towards this goal.

# Our Mission and Objectives

WildTrack's Mission is to protect endangered species using a unique combination of advanced data analytics, artificial intelligence, and traditional ecological knowledge. By integrating traditional ecological tracking skills with a customised model in JMP software and artificial intelligence, we engage the whole community from scientists, to indigenous trackers, local communities and recreational citizen scientists. The data we gather inform on species protection and the mitigation of human-wildlife conflict. They are also essential to reduce the risk of future pandemics.



*A two way learning process - we learn from traditional ecological expertise, and we help local communities use technology to democratize data collection for conservation. It's a win-win.*

## Objectives:

*To develop and apply non-invasive and objective censusing and monitoring techniques as a fundamental resource for wildlife conservation.*

*To revive, value and engage expert local ecological knowledge in communities who have lived with endangered and elusive species over generations.*

*To use the power of scientific networking to augment data collection from endangered species around the world. Footprints are ubiquitous, and can be easily and opportunistically collected by anyone with a smartphone or camera*

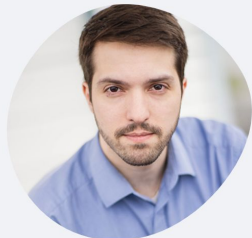
# Our Team: Engineering, Research and Operations

## Tech Team



**Jonathan D'Souza**

LEAD ARCHITECT



**Nicolas Morant**

ENGINEERING PROJECT MANAGER | ML ENGINEER



**Richard Morello**

SOFTWARE ENGINEER



**Brian Adkins**

SYSTEM ENGINEER



**Sathvik Prasanna**

MOBILE APP ENGINEER

## Operations Team



**Kari Dorth**

OPERATIONS MANAGER

## Principal Research Associates



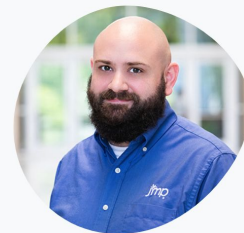
**Peter R. Law., D.Phil**

ECOLOGICAL MODELING/MATHEMATICS



**Ryan Lekiewitz, Ph.D.**

STATISTICS



**Caleb King, Ph.D.**

STATISTICS

# Our Team: Principal Volunteers



**Noah D'Souza**

STUDENT



**Aaditya Ramesh**

SOFTWARE ENGINEER

## Volunteer Team



**Huayu Tsu**

MACHINE LEARNING ENGINEER



**Debbie Liske**

DATA SCIENTIST



**Yolanda Davis**

DATA SCIENTIST

# WildTrack Projects



# 2022-3 by numbers

35 Species Projects

41 Species algorithms  
Developed across 20  
counties and 5 continents

25

Students

Undergraduate  
and  
Postgraduate

15 Partner Universities

26

Scientists supported  
to use our software in  
JMP

AI Platform: 18,500 images, 60 species modelled, 98% species accuracy, 87% individual accuracy

# WildTrack's Footprint Identification Technology (FIT) offers a transformative solution



We have developed the world's first end-to-end solution to monitor species using footprints.

Footprints are a rich source of data, and a transformative solution for conservation monitoring. They're much easier to find than animals themselves, they're easy to collect with a smartphone app, and they're rich in information (Jewell et al, 2020)

Footprint Identification Technology	Other commonly used techniques
Footprints are ubiquitous data - easy to collect and accessible for citizen scientists	Locating endangered species is difficult, and sometimes dangerous
Footprint collection is cheap - using just a smartphone app or simple camera, large volumes of data can be collected	Fitting instrumentation to animals is very expensive so can only be undertaken with small subsets of populations.
Collection is non-invasive, no impact on data quality	Tagging/collaring etc is invasive, which can negatively impact physiology and behaviour
Is based on expert tracking skills, so engages local indigenous communities.	Rarely engage traditional ecological knowledge
Objective and rapid classification at species, individual, sex and age-class using AI	Are often dependent on subjective assessment - eg Camera trap arrays and usually only to species level





# Footprint identification technology for wildlife conservation

Baseline data from Footprint  
Identification Technology (FIT) in JMP

## Data-driven conservation strategies

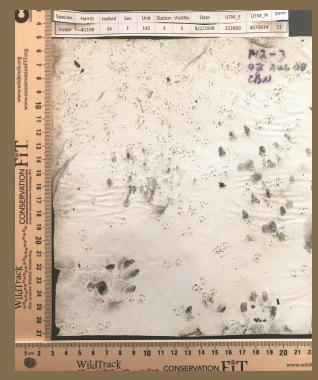
eg Fisher in California  
Small mammals Africa/Europe/North  
America  
Otters in Europe and Asia

## Reducing human-animal conflict

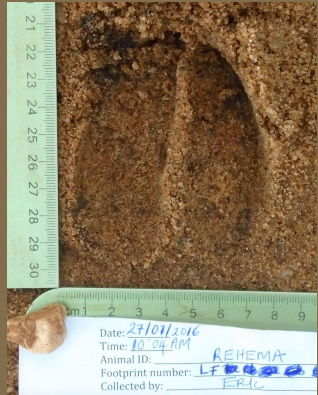
eg Bengal tiger in Nepal  
Hyena in Zimbabwe  
Lion and leopard in Botswana

## Preventing Illegal trade in wildlife products

eg Black rhino in Namibia  
Box turtle in North Carolina  
Indian Star tortoise in India



# Key achievements 2022-3



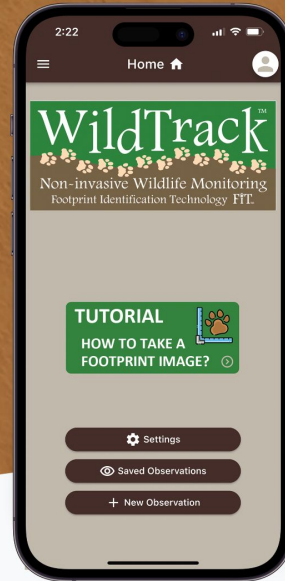
# Research and Development: Launching the WildTrackAI mobile app

Manage all your observations in one place

WildTrackAI mobile app is available on Android and iOS

APP STORE

GOOGLE PLAY



Features:

Free, and easy to use: Users are guided through the process of creating their observations

Use it anywhere. The app works offline too. Users can collect images in remote areas and upload observations later

Contribute to conservation. WildTrackAI is a tool for monitoring endangered species. Your observations will be used to help protect wildlife and their habitats

Species names in both Latin and Common forms

Available on iOS or Android, an easy-to-use app designed for communities worldwide to collect footprint images!

# Research and Development: Data Science

## KEYPOINT DETECTION

### Hand Annotate

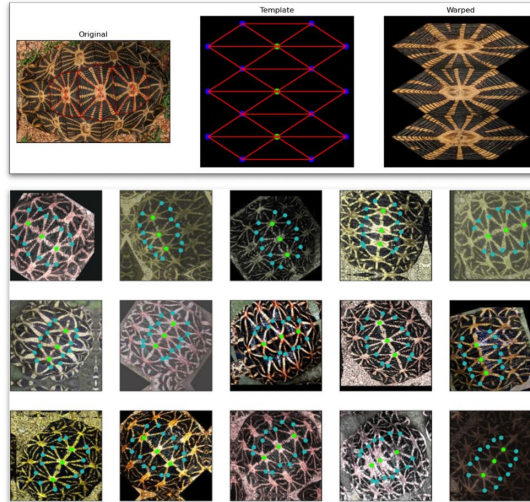
- 186 images/27 individuals
- 17 keypoints (14 corners, 3 centers)

### Transfer Learning

- MobileNetV2, EfficientNetV2-B0, DenseNet121
- Add top dense layer (34 nodes)

### Image Augmentations

- Random rotate, filp, saturation, hue, contrast, etc...
- Greatly prevents overfitting



We co-supervised three post-graduate Data Science student teams at Harvard University to

1. Automate the identification of at-risk Chelonians such as the Star Tortoise (left).
2. Develop an automated quality assessment for footprints entering the pipeline, strengthen species and individual ID classification models
3. Automatically detect a ruler scale in an image, and use the gradations to measure the dimensions of a footprint.

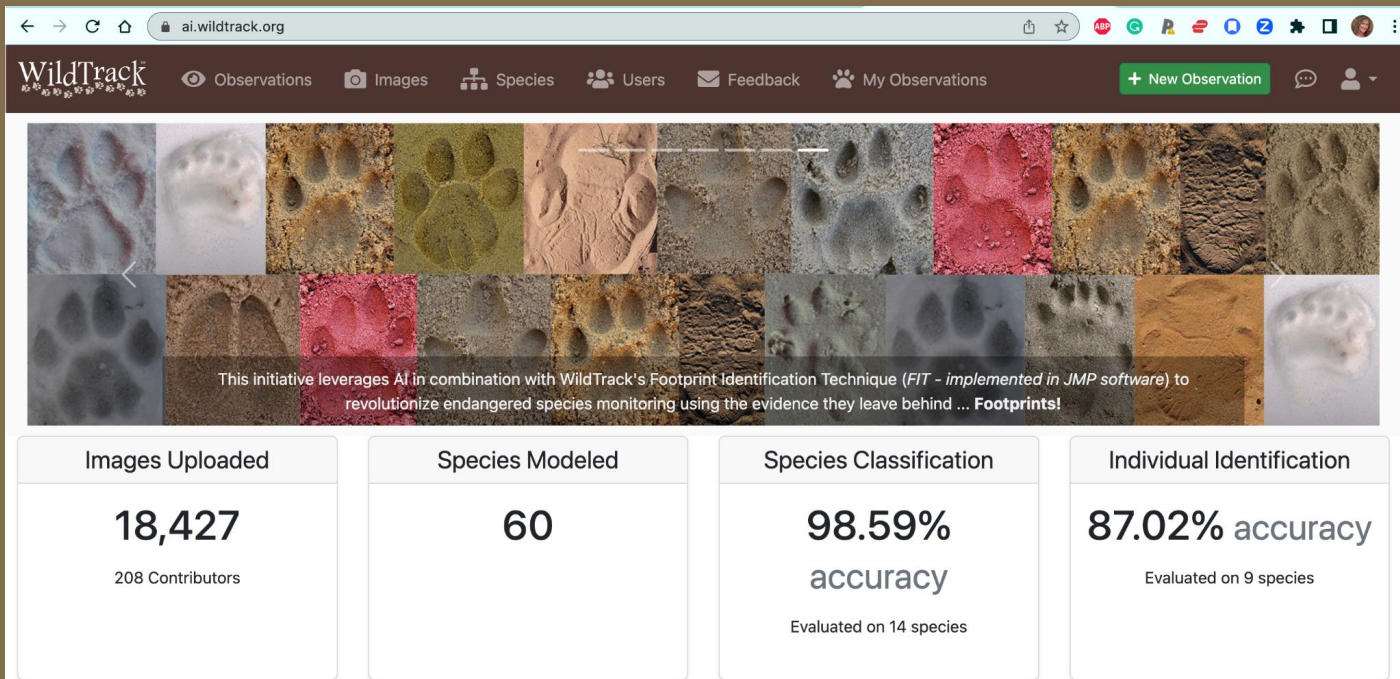
Smartphone App takes footprint images and uploads to cloud.

AI Solution classifies species, individual and potentially sex and age-class

User gets rapid feedback, education and ongoing engagement as part of community of collectors

Database grows, algorithms strengthen, conservation strategies become solidly data-driven.

# Research and Development: Refining the AI Platform



Our WildTrack team of software engineers upgraded our AI platform database to SQL producing a faster and more reliable user interface.

We also migrated the system to the AWS Cloud and are excited to have the support of their expert team and connections to partners for development moving forward.

In the first half of 2023 we have started working with a Harvard student team to migrate to a modular Agile technology for more flexible development and integration moving forward.

# Field Projects: Small mammal project distribution

## WildTrack Small Mammal Projects using Track Plates

**WildTrack**<sup>TM</sup>  
Non-invasive Wildlife Monitoring  
Footprint Identification Technology FIT.

● **Fisher & Small mammals**  
**USA**  
Jody Tucker, Sierra Nevada Carnivore Monitoring project, US Forest Service

● **Small mammals**  
**USA**  
Robyn Jensen, California State University

● **Small mammals**  
**UK**  
Nida Al-Fulajj & Ellie Scopes Peoples Trust for Endangered Species  
Sophie Laurie, Somerset Wildlife Trust

● **Small mammals**  
**Greece**  
Christos Astaras, Forest Research Institute, Thessaloniki

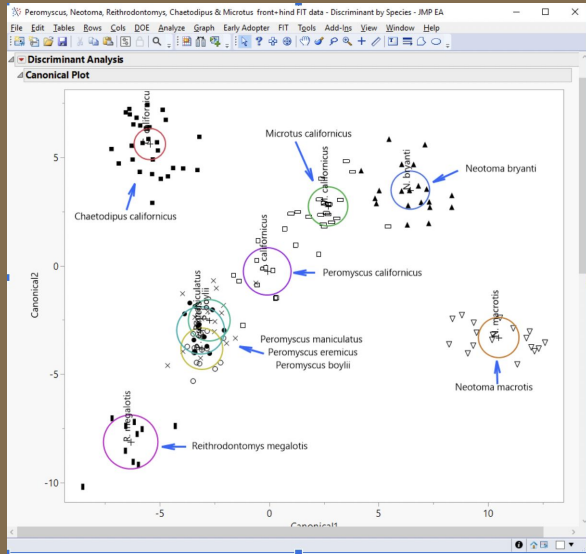
● **Small mammals**  
**Lebanon**  
Samara P.EL Hadad & Karma Bouzza, Lebanon Reforestation Initiative

● **Small mammals**  
**Israel**  
Asaf Ben David, Tel Aviv University

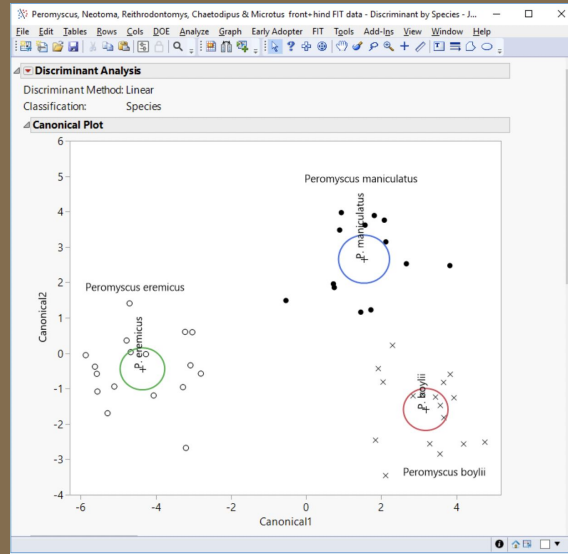
● **Small mammals**  
**South Africa**  
Nico Avenant, National Museum, Bloemfontein



# Field Projects: Small mammal monitoring using track plates



Separation of 9 North American small mammal species using morphometrics of hind footprint collected from track plates (Alibhai & Jewell, in prep.) Note three *Peromyscus* sp. with overlapping distributions.



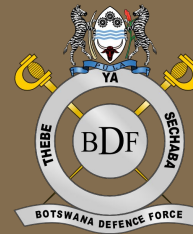
The same morphometric analysis applied only to the three overlapping species of *Peromyscus*, presenting a clear separation between *P. eremicus*, *P. maniculatus* and *P. boylii*

Using track plates, and morphometrics analysis in JMP, we are able to identify small mammal species by their footprints.

Small mammals are excellent indicators of environmental health as their populations fluctuate rapidly with changes in the environment

In these two figures we show how even species that are morphologically almost impossible to discriminate by eye, can be identified using FIT.

# Black rhino monitoring in Botswana



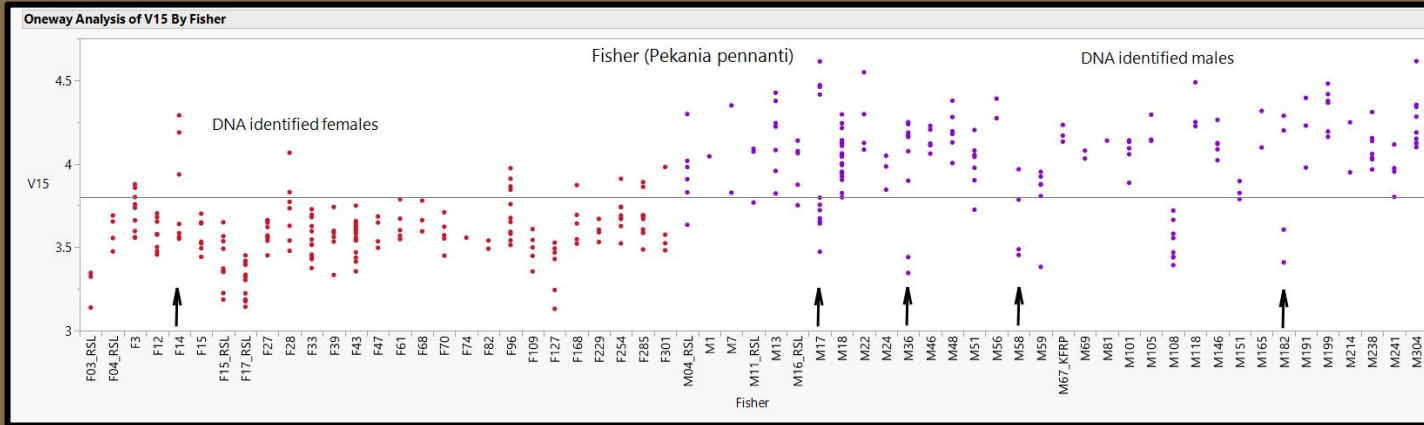
An aerial image of a male rhino (R) in a standoff with a female, sub-adult calf and calf (L). Drones can allow us to observe behaviour that we are rarely able to access on the ground

This project, in collaboration with the Botswana International University of Science and Technology, and the Botswana Defence Force (BDF) will collect aerial images of rhino trails using drones and interpret these using AI and traditional ecological knowledge.

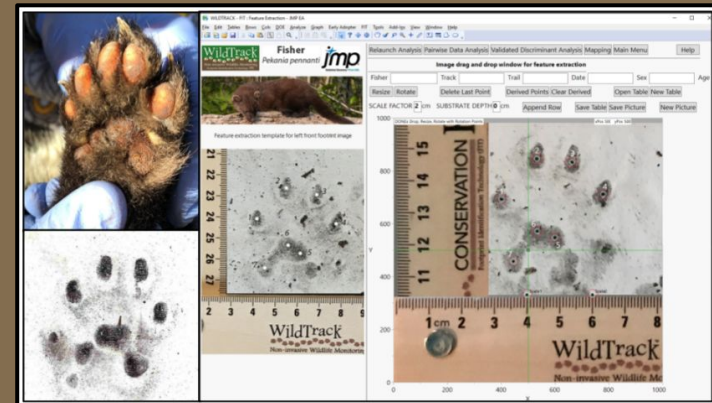




# Fisher Conservation in California

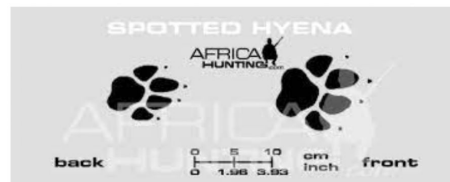


Fisher populations are in decline in California as forest fires impact their habitat. This project, in collaboration with the US-Forest Service, has demonstrated that the Fisher can be sexed using FIT in JMP, from footprints collected on track plates. This allows biologists to identify those areas where female fisher are resident and protect them.



# Human:wildlife mitigation projects in Southern Africa

Humans and wildlife are increasingly coming into conflict. In the Gonarhezhou National Park, Zimbabwe, part of the Greater Limpopo Transfrontier Conservation Area, hyena frequently take livestock from villagers in the outlying areas. Retribution killings of hyena and other large carnivores are common. We're working with Professor Walter Musakwa of the University of Johannesburg in South Africa to identify problem animals at kill sites using footprints, and working with local communities to find solutions to avoid conflict.



Professor Walter Musakwa is in the Dept of Geography and Environmental Management and Energy Studies at the University of Johannesburg. His multidisciplinary approach includes sustainable development and livelihoods, which is key to mitigating Human:Wildlife conflict

# Engaging the skills of expert women trackers for FIT development

Women have traditionally been under-represented in the art and science of tracking, so we're delighted to be able to work with several expert women trackers, including our three colleagues below.



Kersey Lawrence PhD, is a wildlife ecologist and award-winning university teacher who holds Cybertracker Track and Sign Specialist and Trailing Specialist qualifications. Kersey is helping the WildTrack Specialist Group community identify cryptic prints and connect in Southern Africa where she spends much of her time.



Kim Cabrera is a Cybertracker Track and Sign specialist, and has been helping WildTrack curate data that are submitted to our site. This includes checking species identifications, and giving prints a quality rating. This is an essential requirement for robust discrimination algorithms



Shane Hawkins holds a level 3 Cybertracker certification, and has already contributed 14 new species to the WildTrack database of footprints.

<https://www.wildtrack.org/blog/Connecting-with-the-Earth-an-interview-with-Shane-Hawkins>

# The WildTrack Specialist group in Portugal

The second WildTrack Specialist Group International Workshop was held in Aljezur, Southwest Portugal, in November 2022. Participants from 10 countries came together to compare field techniques and share a wide range of experiences. Several new projects were spawned and new collaborations generated.



# WildTrack Conservation Outreach - Media snapshot



Virtual Knowledge Dialogue/  
High-Level Political Forum 2022 Official Side Event

“Knowing Nature: new conservation technologies and knowledge systems to support the SDGs and post-2020 Global Biodiversity Framework”

We had a wide range of media outreach including a podcast and blog for NVIDIA, an IUCN representation, Insider business post and our weekly newsletter that began in 2022 and now has almost 1000 subscribers



MORPHOMETRICS

JMP software solves otterly confusing challenge!

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INSIDER

In September 2021, officials in Bokakhat, Assam, India burned 2,467 rhino horns primarily seized from illegal trade. David Talukder/NoPhoto via Getty Images

- Researchers and scientists are using artificial intelligence tools for conservation efforts.
- AI tools can help with efforts like identifying tracks to better understand animal populations.
- Using AI can help conservationists more wisely deploy scarce resources.

NVIDIA

HOME AI DATA CENTER DRIVING GAMING PRO GRAPHICS AUTONOMOUS MACHINES HEALTHCARE STARTUPS AI PODCAST

## HORN Free! Roaming Rhinos Could Be Guarded by AI Drones

November 9, 2022 by BRIAN CAULFIELD

WildTrack

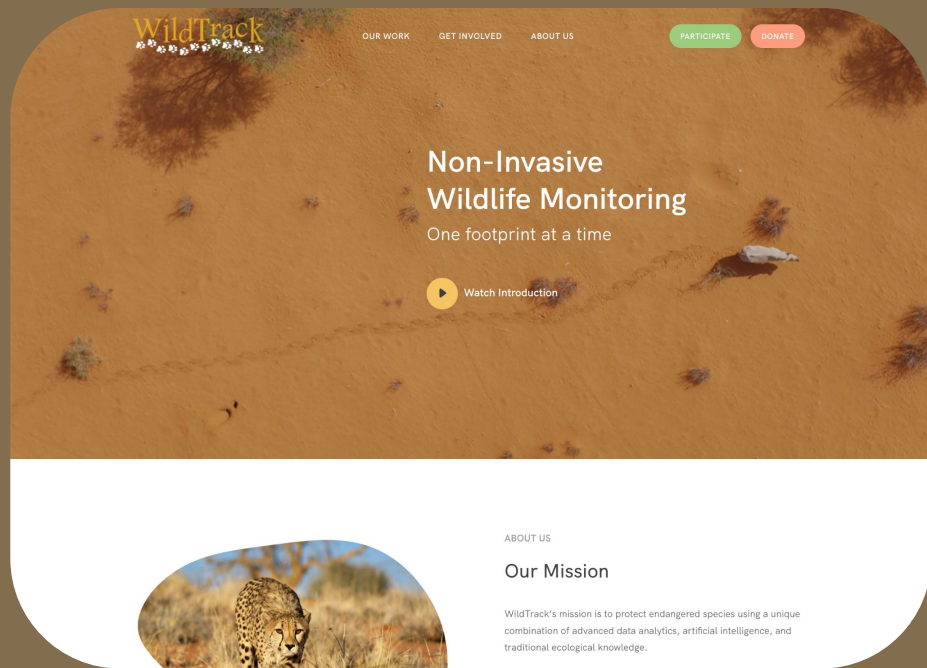
## April 2023 Newsletter

Celebrating Earth Day this Month!

Humans depend on biodiversity, and this month we take a deeper dive into the importance of this dependency and what you can do to protect it.

How can you better connect with the earth? Get outside and get giddy! Read our newest [blog interview with Shane Hawkins](#) and realize how you too can become a tracker in your free time.

# WildTrack Conservation Outreach - New website!



Our new website provides a more interactive interface with many options to participate in our work



An explainer video showcases our vision for FIT (<https://www.wildtrack.org/get-involved/collect-footprints>)

# Award-winning and most-viewed Publications

PeerJ  
an eScholarnet journal

< BIODIVERSITY AND CONSERVATION

Protecting endangered megafauna through AI analysis of drone images in a low-connectivity setting: a case study from Namibia

View 15 tweets

Related research

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Research article Conservation Biology Zoology Computational Science

Data Mining and Machine Learning

Alice Hua<sup>\*1</sup>, Kevin Martin<sup>\*1</sup>, Yuzeng Shen<sup>1</sup>, Nicole Chen<sup>1</sup>, Catherine Mou<sup>1</sup>, Maximilian Sterk<sup>2</sup>, Berend Reinhard<sup>3</sup>, Friedrich F. Reinhard<sup>3</sup>, Stephen Lee<sup>4</sup>, Sky Alibhai<sup>5,6</sup>, Zoe C. Jewell<sup>5,6</sup>

Published August 3, 2022

Read the peer review reports

This paper published in Peer J was one of the top 5 most viewed #ComputationalScience articles published in @PeerJLife journal in 2022

Student honors: **Stacey Fletcher** University of Kent UK: 1st Class Honors for undergraduate study on beaver reintroduction using FIT  
**Kristina Grant** Durrell Institute of Conservation Ecology (DICE) UK: Distinction in Masters project on cheetah identification using FIT  
**Harvard team IV**: Distinction in Master's project on AI pipeline development for WildTrack.

Published in the International Otter Survival Fund journal, this paper won an Otter Oscar award for best research paper



AWARD

WildTrack awarded Otter Oscar for research paper!



ELSEVIER

Ecological Informatics

Volume 73, March 2023, 101947



'I know the tiger by his paw': A non-invasive footprint identification technique for monitoring individual Amur tigers (*Panthera tigris altaica*) in snow

Sky K. Alibhai<sup>a b 1</sup>, Jiayin Gu<sup>c 1</sup>, Zoe C. Jewell<sup>a b</sup>, Joseph Morgan<sup>b</sup>, Dan Liu<sup>d</sup>, Guangshun Jiang<sup>c</sup>

Published in Ecological Informatics with colleagues in China

# WildTrack Board Members

**Zoe Jewell**, President and co-founder of WildTrack, Programs and Strategy. M.Sc., M.A., Vet. M.B., M.R.C.V.S.

**Sky Alibhai**, Director and co-founder of WildTrack, Programs and Software Development. D.Phil. (Oxon).

**James Baker**, Director. Legal Affairs. B.S., J.D, Attorney at Law, Hedrick Gardner Kincheloe & Garofalo LLP.

**Laurie Durham**, Director, Finance. B.A. Finance Director, SAS.

**Charles Hall**, Director, Web applications. B.Sc. Web Applications Developer, SAS.

**Joseph Morgan**, Director, Technology and Innovations, B.Sc. Principal Research Statistician, JMP.

**Onyi Nwafor**, Director, Operations and Logistics. Ph.D. Assistant Professor, Bryan School of Business, UNC Greensboro

WildTrack is a Platinum member of GuideStar and our organisational [reports and credentials are available here](#).



# WildTrack™



Non-invasive Wildlife Monitoring

# FIT™

We thank our extraordinary partners, who contributed so much to WildTrack's success in 2022-3, including:



Harvard John A. Paulson School of Engineering and Applied Sciences



With gratitude to our  
donors, directors,  
colleagues,  
supporters and  
students

You Inspire Us



*A brown hyena (Hyaena brunnea) in the  
Kalahari desert, South Africa.*