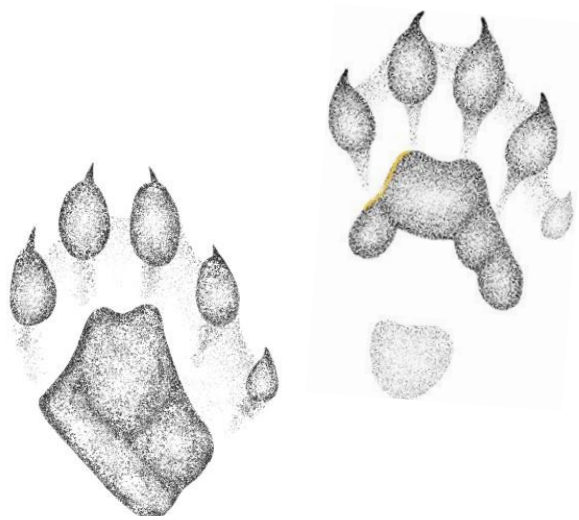
EURASIAN OTTER WORKSHOP
26-28 February 2021

DBU

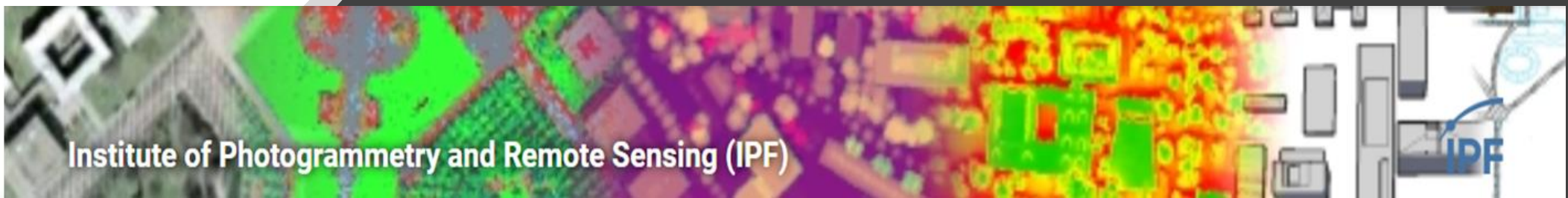


Footprint Identification Technology (FIT) for monitoring Eurasian Otters

By Dipl. Uwi. Frederick Kistner

WildTrack
Non-invasive Wildlife Monitoring

KIT
Karlsruher Institut für Technologie



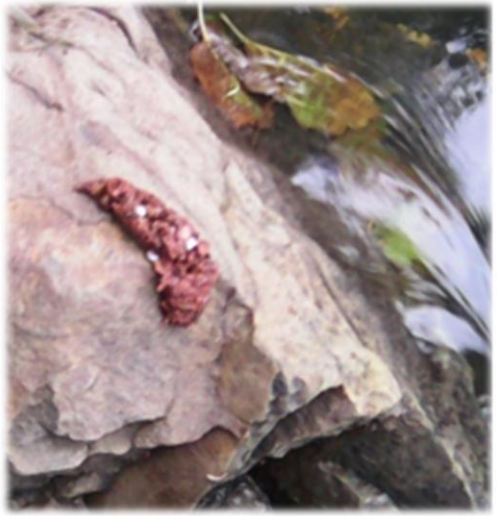
Outline

I. Introduction

II. The Present: FIT for the Eurasian Otter based on biometrics

III. The Future of FIT using Artificial Intelligence (AI)

IV. How FIT can be implemented in your research and how you can contribute to our crowdsource AI development approach



I. Introduction

Vol. 4: 205–218, 2008 | ENDANGERED SPECIES RESEARCH | Printed January 2008
doi: 10.3354/esr00067 | Endang Species Res | Published online January 18, 2007

OPEN ACCESS

THEME SECTION

A footprint technique to identify white rhino *Ceratotherium simum* at individual and species levels

Sky K. Alibhai[1], Zoe C. Jewell[1,*], Peter R. Law[2]

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Wildlife Society Bulletin; DOI: 10.1002/wsb.432

Original Article

Sex Determination of Amur Tigers (*Panthera tigris altaica*) From Footprints in Snow

JIAYIN GU[1], *College of Wildlife Resources, Northeast Forestry University, 26 Hexing Road, Harbin, Heilongjiang 150040, P.R. China; and Feline Research Center of Chinese State Forestry Administration, Harbin 150040, P.R. China*
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ZOE C. JEWELL *Nicholas School of the Environment, Duke University, Box 90329, Durham, NC 27708, USA*
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WildTrack

Non-invasive Wildlife Monitoring

jove Journal of Visualized Experiments www.jove.com

Video Article

Spotting Cheetahs: Identifying Individuals by Their Footprints

Zoe C. Jewell[1,2], Sky K. Alibhai[1,2], Florian Weise[3,4], Stuart Munro[3], Marlice Van Vuuren[5], Rudie Van Vuuren[5]

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Correspondence to: Sky K. Alibhai at wildtrack.monitoring@gmail.com

URL: http://www.jove.com/video/54034
DOI: doi:10.3791/54034

Keywords: Environmental Sciences, Issue 111, Footprint identification, *Acinonyx jubatus*, non-invasive monitoring, conservation, endangered species, image recognition, statistical modeling.

Date Published: 5/1/2016

Citation: Jewell, Z.C., Alibhai, S.K., Weise, F., Munro, S., Van Vuuren, M., Van Vuuren, R. Spotting Cheetahs: Identifying Individuals by Their Footprints. *J. Vis. Exp.* (111), e54034, doi:10.3791/54034 (2016).

[Publications]

Non-invasive Monitoring from the ground up

Working hypothesis: „The (multivariate) variance of the tracks of different otter individuals is often bigger than environmentally introduced variance of tracks, therefore images of footprints can be a useful source of information to monitor Eurasian Otters (*Lutra lutra*).“

→Is it possible to identify individual otters with tracks even though every footprint is unique?

Publication	Method	Key Points:
Home Range of the Otter (Lutra lutra) in Southern Sweden **S.Erlinge (1967)**	• Tracking • Measurements of plaster casts	• Individuals • Home range
Estimating the density of Otter (Lutra lutra) populations using individual analyses of tracks **K. Hertweck et. al (2002)**	• Digital measurements of digital images • Discriminant analysis (**DA**) as classification model	• Standardised image collection protocol • Measurements in digital images • Multivariat statistical approach to attribute tracks in a trail to individuals
Preliminary study of the tracks of captive otters as a tool for field research **L. Mercier& G.Fried (2005)**	• **DA** & • Digital measurements	• Footprints of captive otters • Sex classification
Identifying individual Eurasian Otters based on Measurements of their footprint's standardization of the method and its potential for censusing and monitoring wild otter populations **I.Větrovcová (2006)**	• **DA** & digital measurements	• Prints of captive and wild otters • Recommended to use **FIT** to overcome limitations of DA

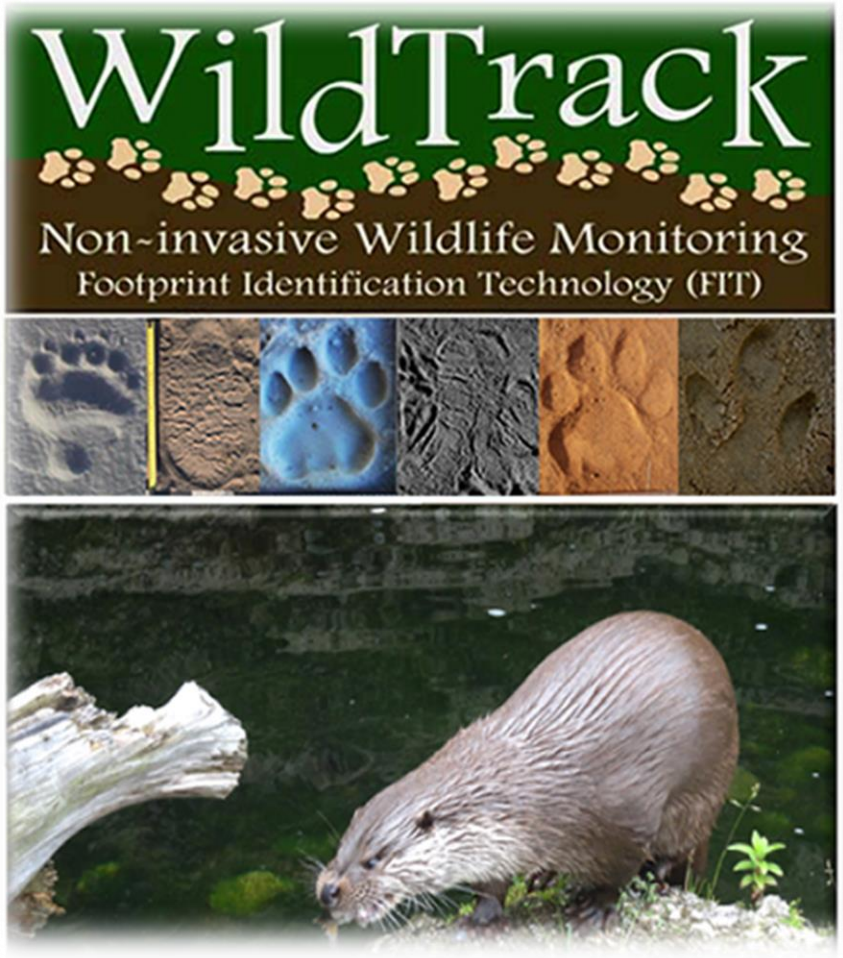
Previous work on Otter tracks

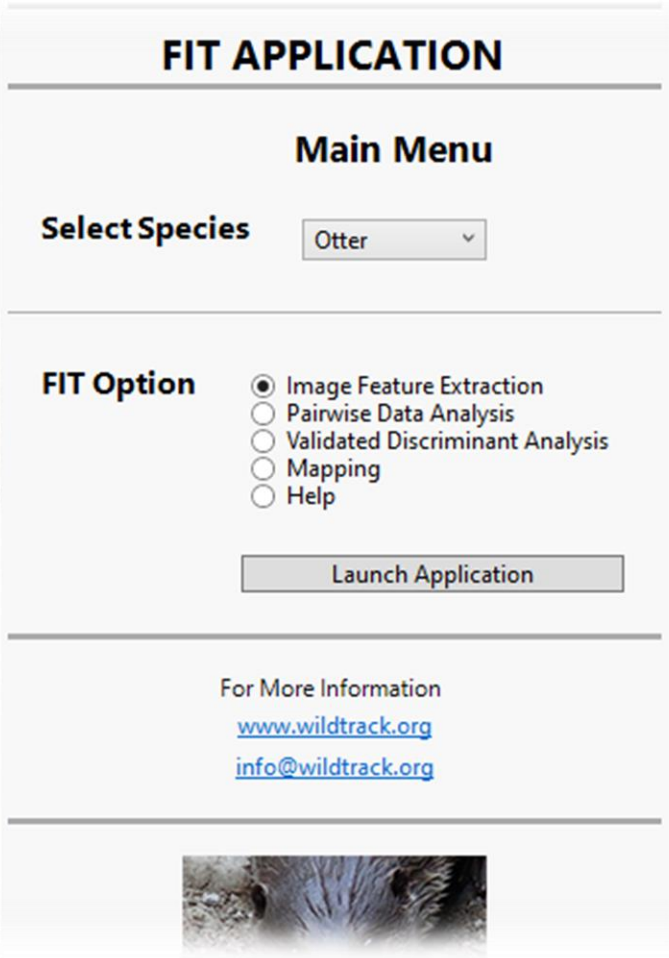
→Is it possible to identify individuals with tracks even though every footprint is unique?

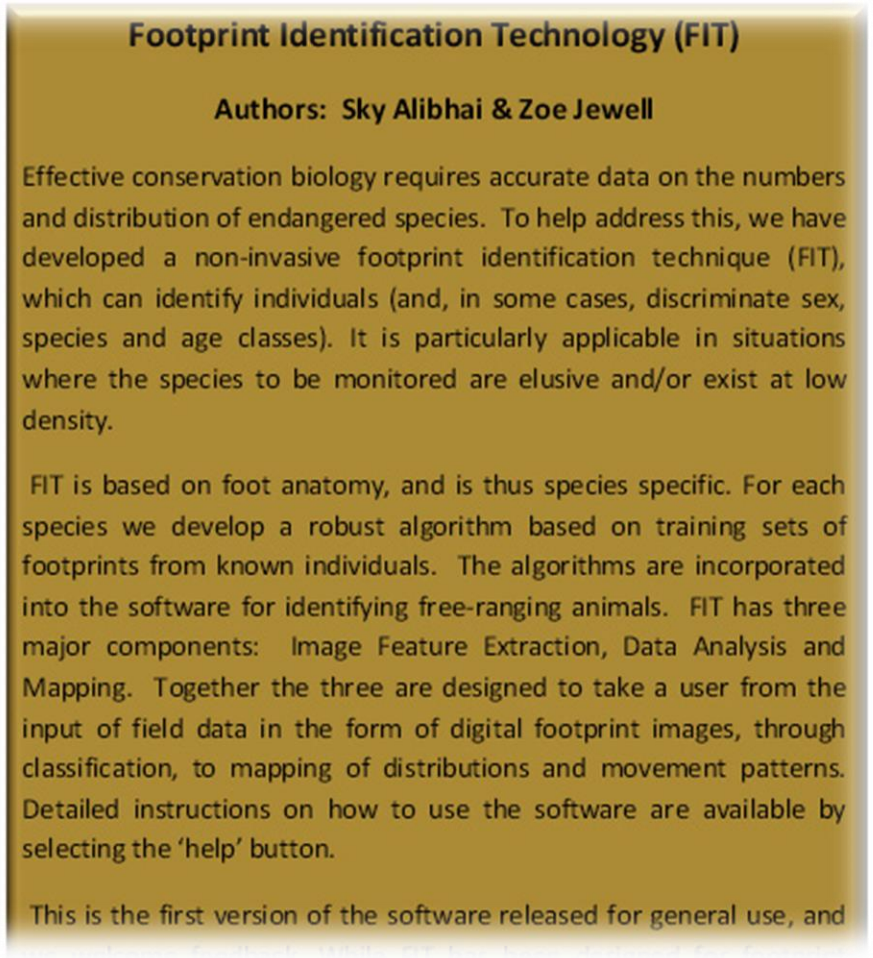
Input

Output

- Species
- Sex
- Individual
- Population Size



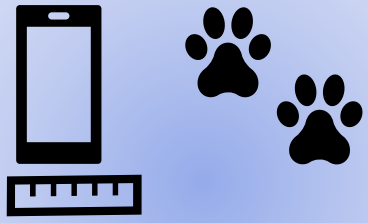




II. The Present: FIT for the Eurasian Otter

Current best practice based on biometrics

Input



Known animals

Training image database

Output

- Species
- Sex
- Individual
- Population Size

- Reference database of known otters (currently N=29)
- Ex-Situ Partners are important for this stage
- Images can be uploaded via app

Input

Unknown animals

Image database

Output

- Species
- Sex
- Individual
- Population Size

- Preparation of sites increase success rate
- Footprints need to be grouped and labelled in **trails**
- FIT can be combined with other non-invasive methods

Input

Known animals

Unknown animals

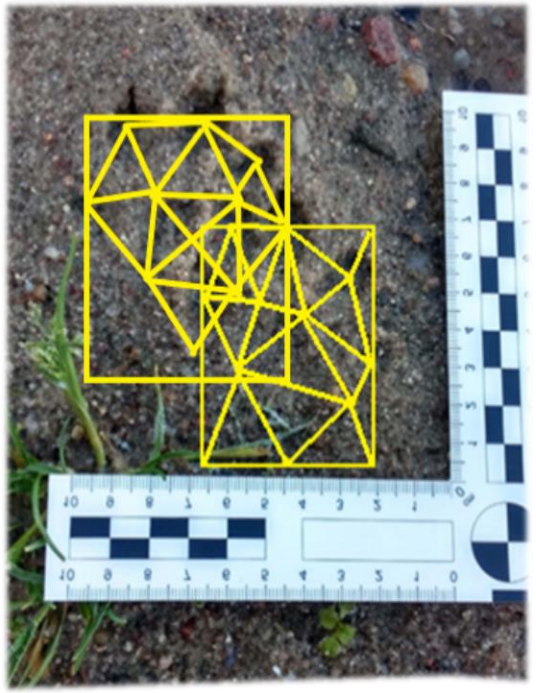


Image database

Geometric Profiles

Output

- Species
- Sex
- Individual
- Population Size

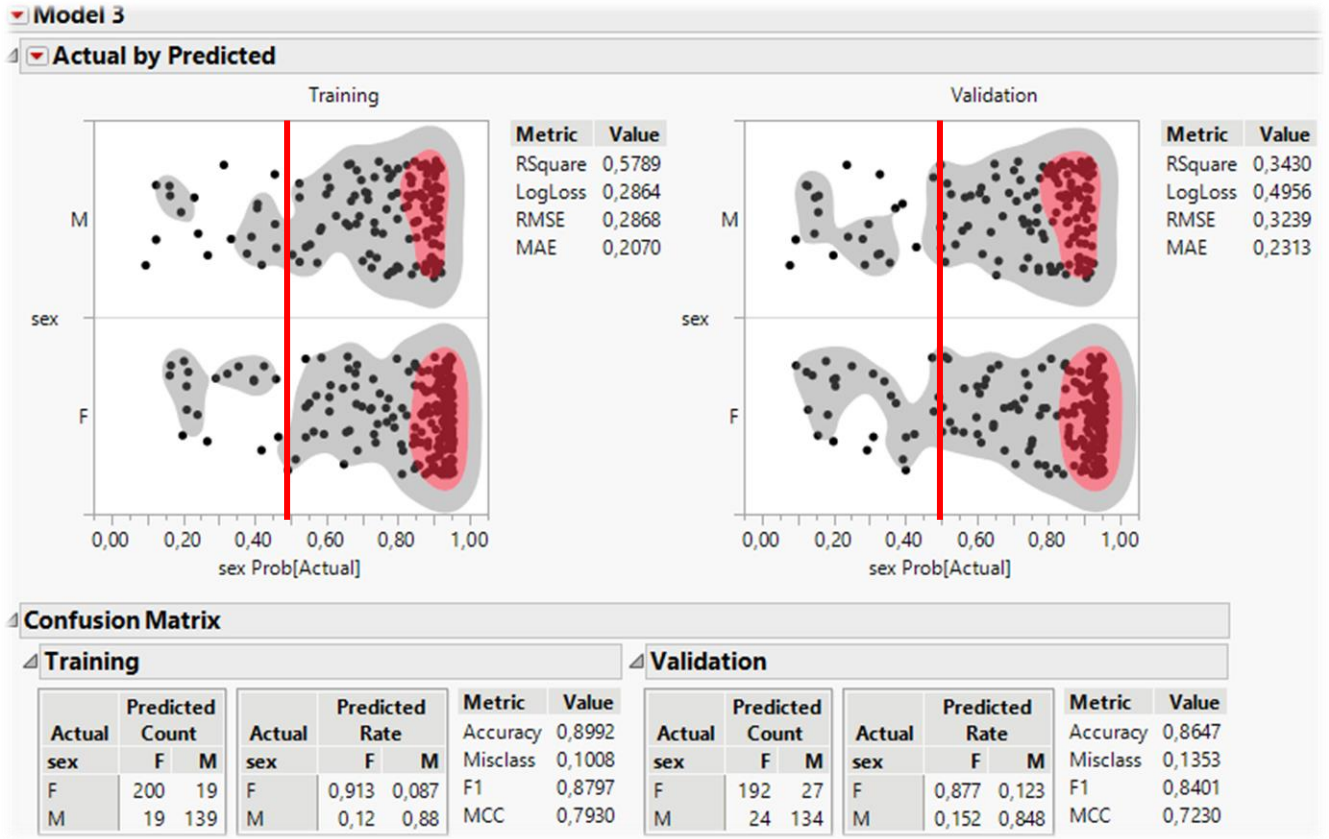
- Pre-defined landmarks are placed manually
- Coordinates to generate geometric profiles (distances, angles, areas, ratios)
- 193 measurements are automatically derived

Input

Known animals

Unknown animals

Image database



Geometric Profiles

Output

- Species
- **Sex**
- Individual
- Population Size

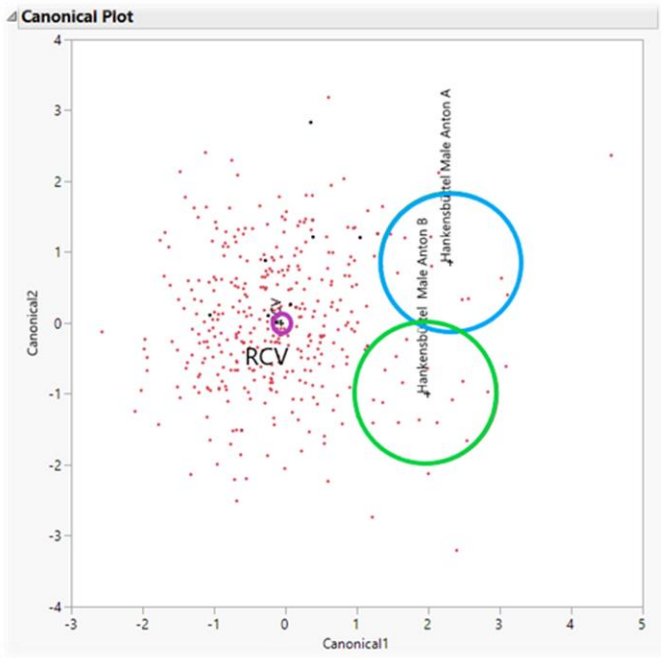
- Geometric profiles train and validate Machine Learning Classification Models
- Sex can be classified on single footprints or trails
- **86% crossvalidated classification accuracy** (preliminary N= 24)

FIT Models

Input

Known animals

Unknown animals



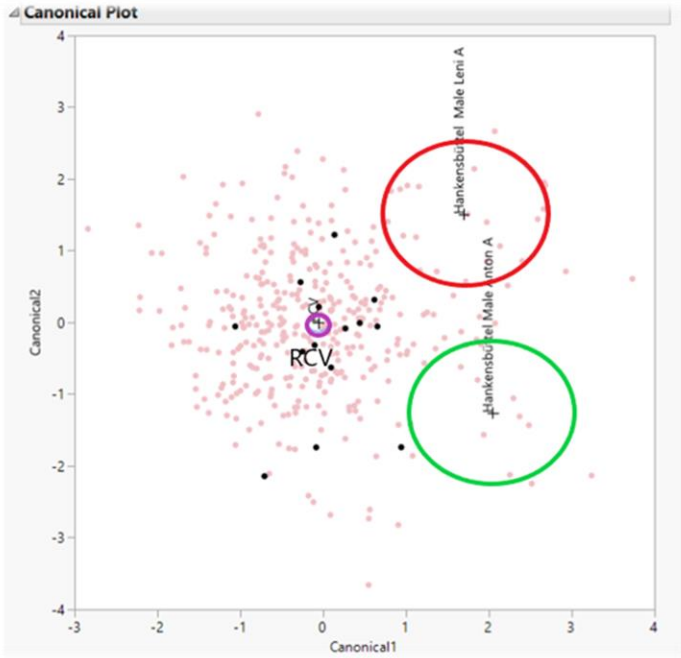


Image database

Geometric Profiles

FIT Models

Output

- Species
- Sex
- **Individual**
- Population Size

- Pairwise Discriminant Analysis between trails
- Reference Centroid Value (**RCV**)
- **93% Pairwise Classification Accuracy** (preliminary, N=24 otters)
- See Alibhai et al. (2008) for details

Input

Known animals

Unknown animals

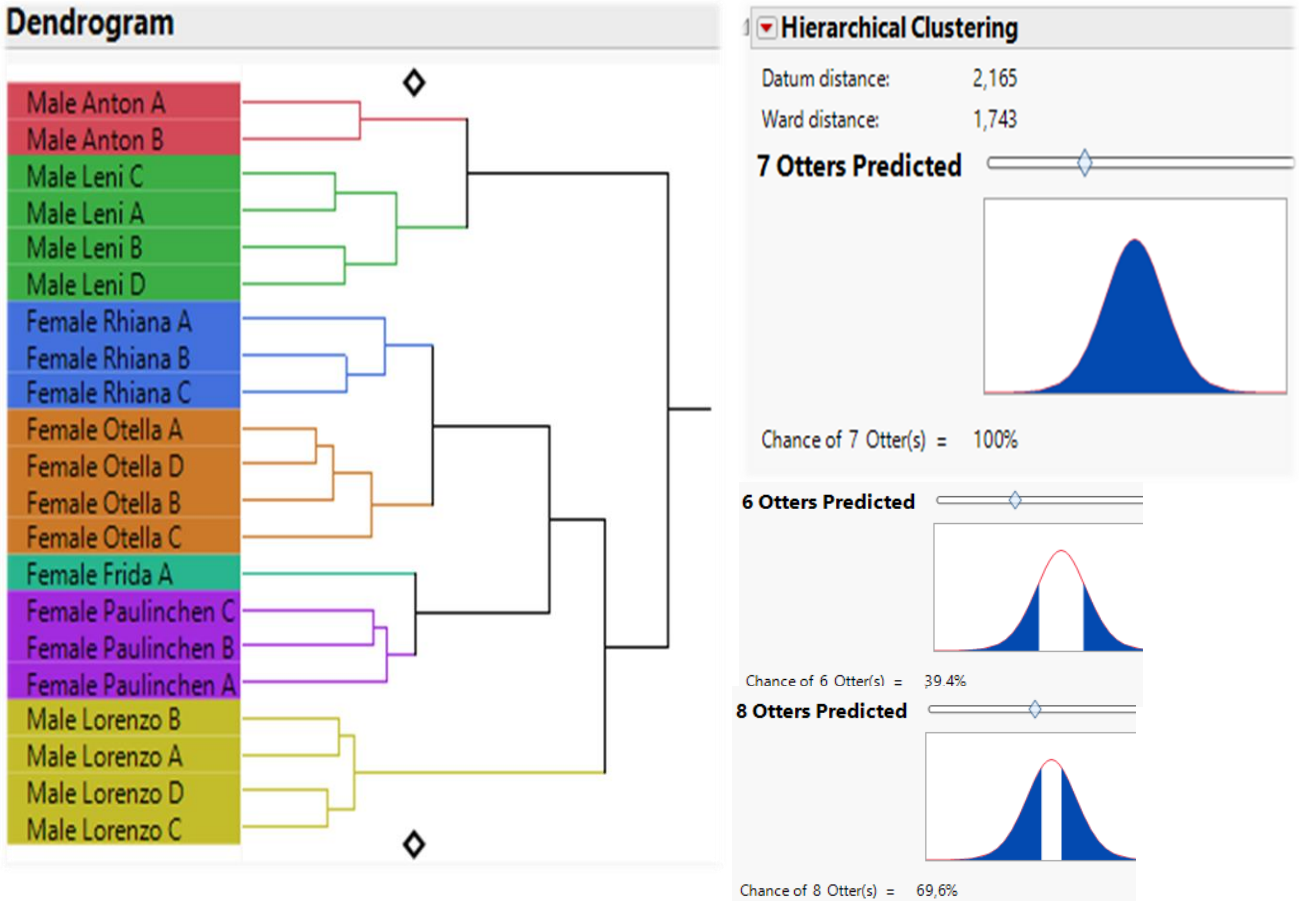


Image database

Geometric Profiles

FIT Models

Output

- Species
- Sex
- Individual
- **Population**

- Hierarchical Cluster Models to assign trails to clusters
- Probabilistic prediction of number of otters
- See Li et al. (2018) for details

Input

Known animals

Unknown animals

Advantages of FIT based on biometrics

- Non-invasive, standardised and cost-effective
- Can be implemented for many species
- Can be combined with other non-invasive methods
- Crossvalidated models with high accuracy

Challenges of the current approach

- For some species/areas hard to find (enough) footprints of decent quality
- Generating geometric profiles is time-consuming and a potential source for operator bias
- Impact of different substrates not yet fully understood

estimation

validation

Image database

Geometric Profiles

FIT Models

Output

- Species
- Sex
- Individual
- Population Size

II. The Future of FIT using Artificial Intelligence

Wildtrack AI

Input

Output

- **Species**
- Sex
- Individual
- Population Size

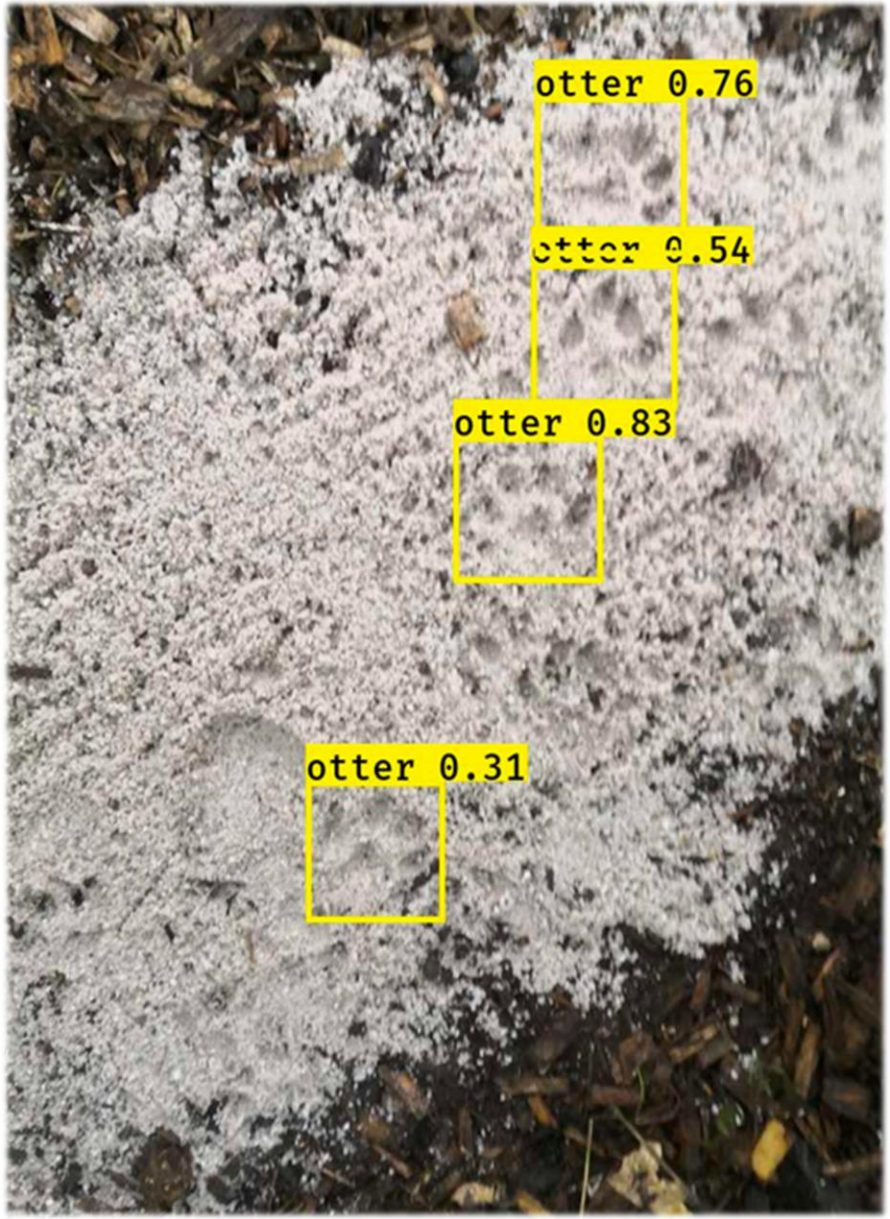
Deep Learning approach:

- Convolutional neural networks (CNNs) with transfer learning
- Multispecies models ***(under development)***
- Implementation in an App for an automated instant output ***(under development)***

Image database

Geometric Profiles

FIT Models



WildTrack™
Non-invasive Wildlife Monitoring
Footprint Identification Technology FIT

Artificial Intelligence for Wildlife Conservation

Images Uploaded	Species Modeled	Species Classification	Individual Identification
9031	13	80% accuracy	67% accuracy
51 Contributors 59 Species	4874 Training Images Covers 210 Individual Animals	Evaluated on 1876 images Average Image Quality: 4.22/5	Evaluated on 402 images Average Image Quality: 4.65/5
Details	Details	Details	Details

III. How can this be implemented in your research? How can you contribute to improve the AI development?

- **Collect footprints from captive and wild animals**
- **Upload images onto our database**
- **Contact us for guidance and cooperation requests**

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WildTrack

Non-invasive Wildlife Monitoring

technische universität dortmund

fakultät statistik

KIT Karlsruher Institut für Technologie

Institute of Photogrammetry and Remote Sensing (IPF)

jmp

Aktion Fischotterschutz

CERES International Project

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