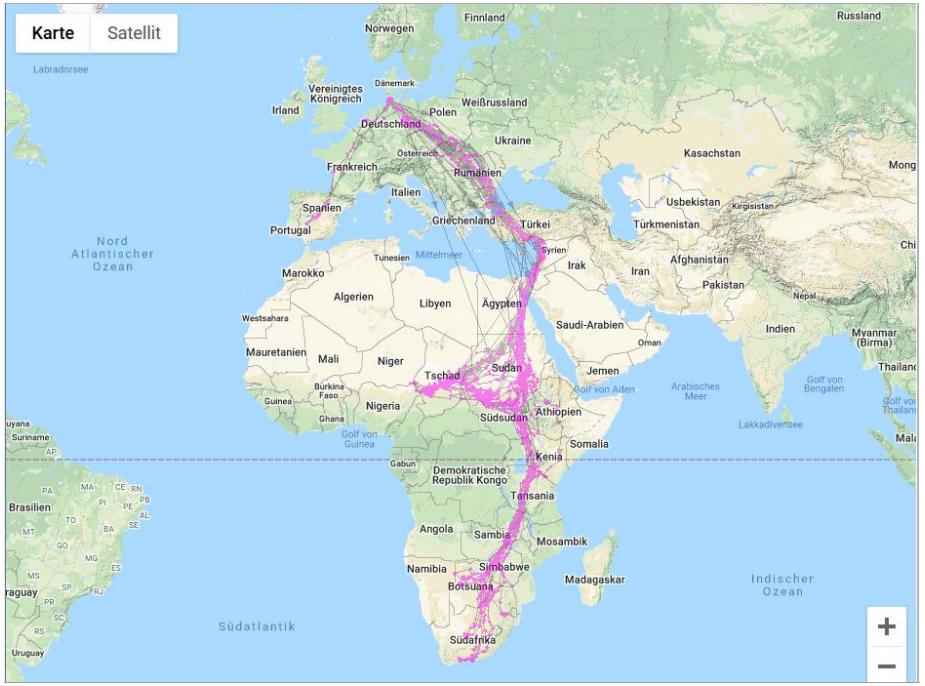
MAX-PLANCK-GESELLSCHAFT

Universität Konstanz

Movebank, Movebank Data Repository und Movebank 2.0



Berthold & Kaatz, 2011.
Movebank ID 446651

Gabriel Schneider & Dr. Elisabeth Böker

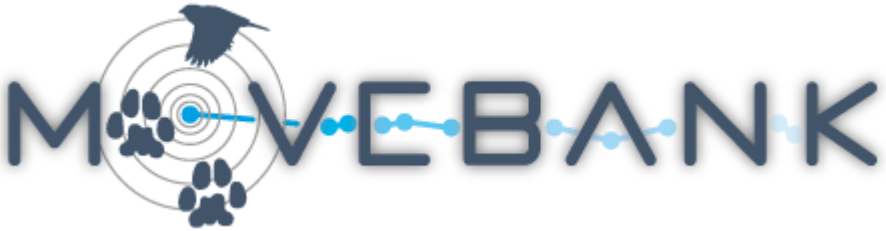
Potsdam, 25.02.20, RDA DE Tagung 2020

MaxPlanckSociety, 2018
https://www.youtube.com/watch?v=RRq-panAKME;
Abgerufen am 25.03.20

Agenda

- Was ist Movebank?
- Ethische & rechtliche Aspekte
- Daten & Metadaten
- Arbeiten mit Movebank
- Movebank Data Repository
- Movebank 2.0
- Kooperationsmöglichkeiten für Infrastruktureinrichtungen

Was ist Movebank?



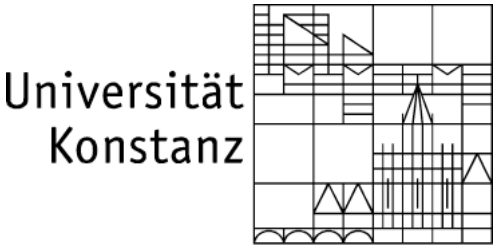
Was ist Movebank?

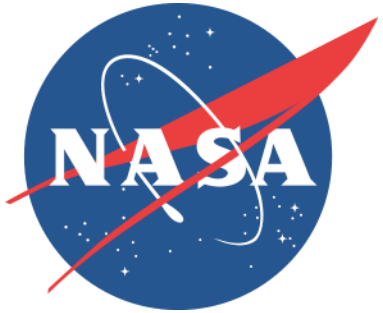
- Globale Datenbank für Tierbewegungsdaten
- Werkzeug zur Arbeit an den Daten während des gesamten Forschungsprozess
- Projektbeginn im Jahr 2007

Tierbewegungsdaten

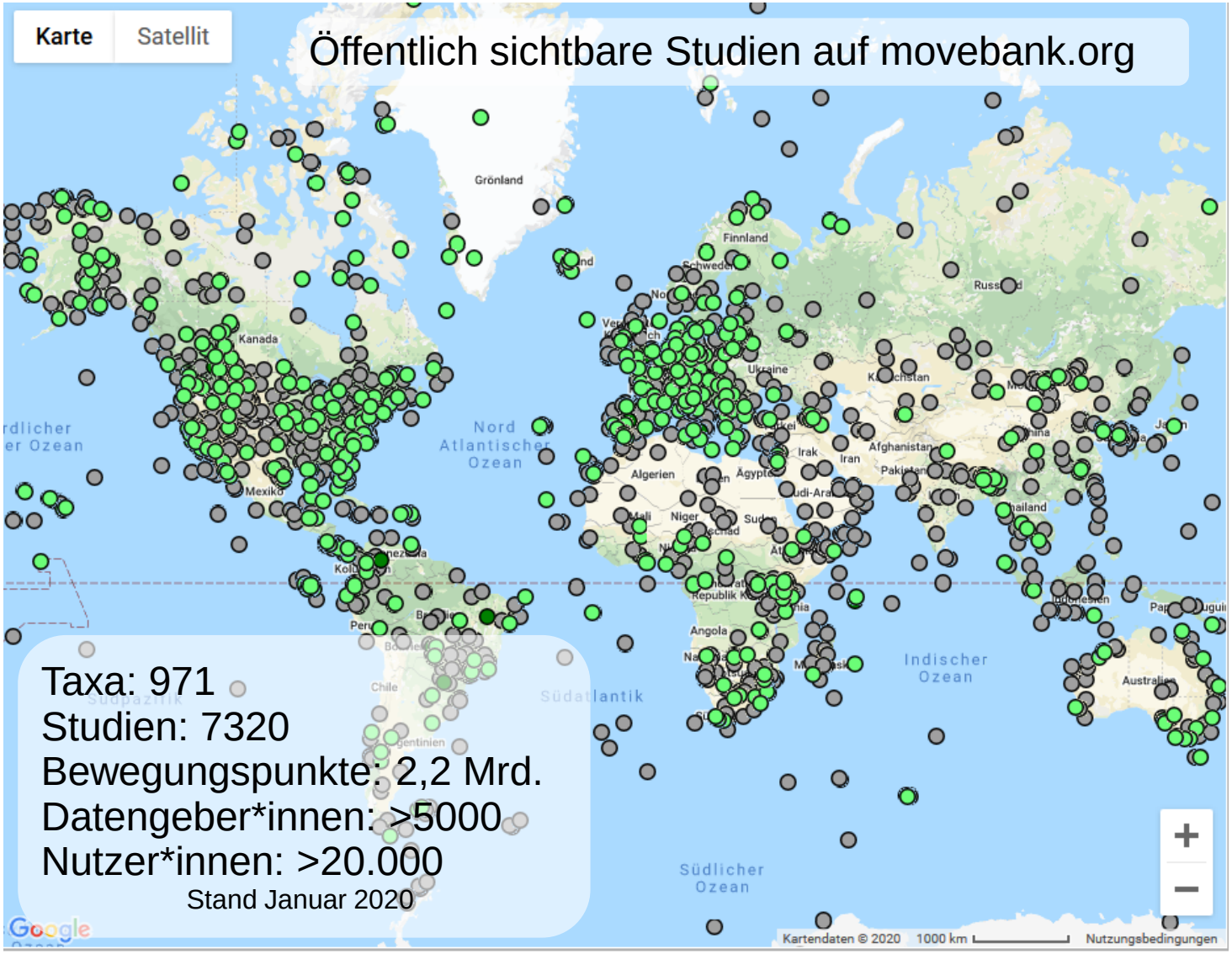
- **Tierwanderungen als Ausdruck auf sich verändernde Umweltbedingungen**
- **Tiere als „Ökosystemdienstleister“**
  - Bestäubung, Schädlingsvernichtung etc.
- **Schwarmverhalten**
- **Aber auch:**
  - Verbreitung von Krankheitserregern
  - Bevölkerungszuwachs → Nähe von Menschen und Wildtieren

Aktuelle & ehemalige Geldgeber & Institutionen

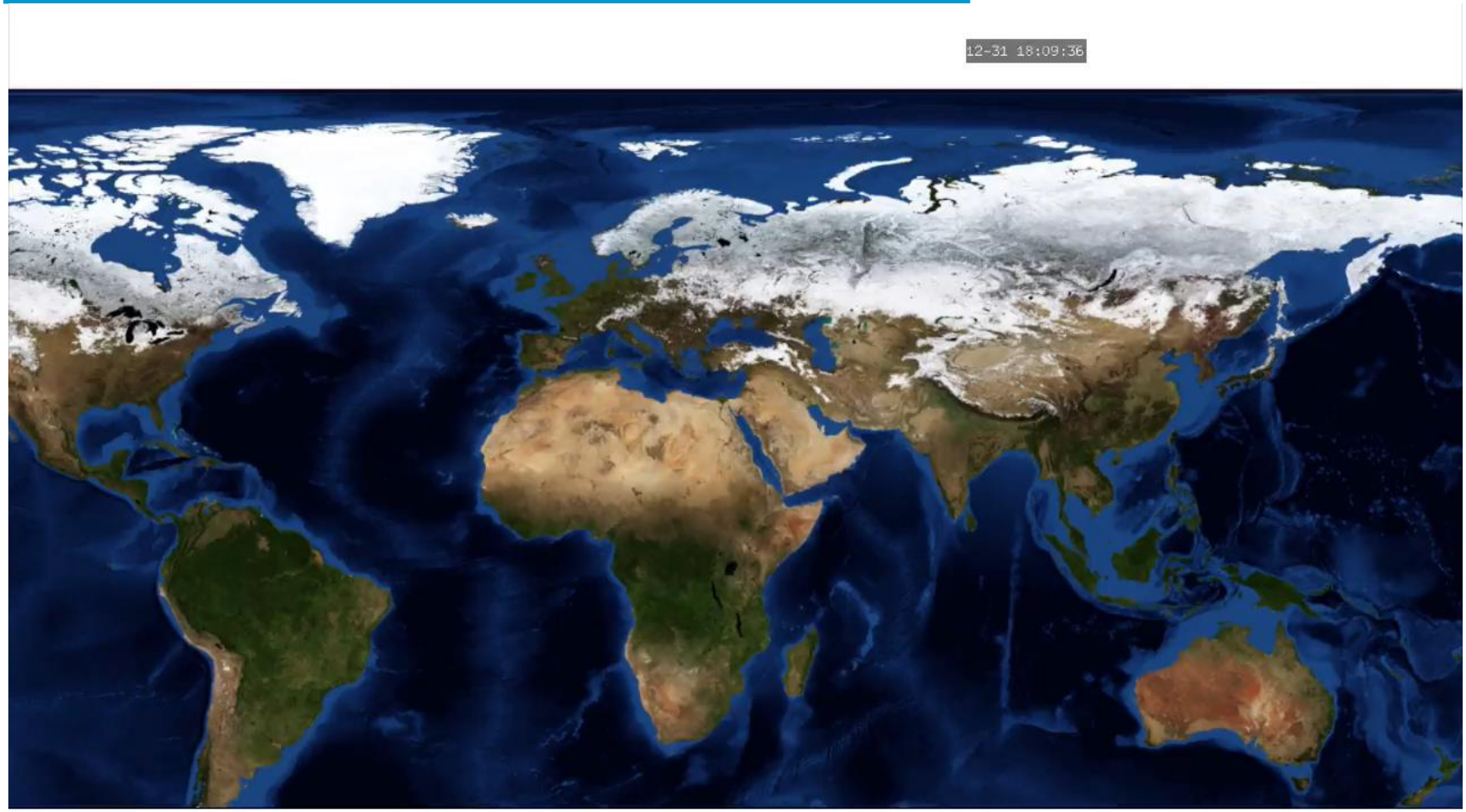




Zahlen & Fakten



Visualisierung öffentlich zugänglicher Daten (2016)



Movebank, 2017
https://youtu.be/nUKh0fr1Od8; Abgerufen am 25.03.2020

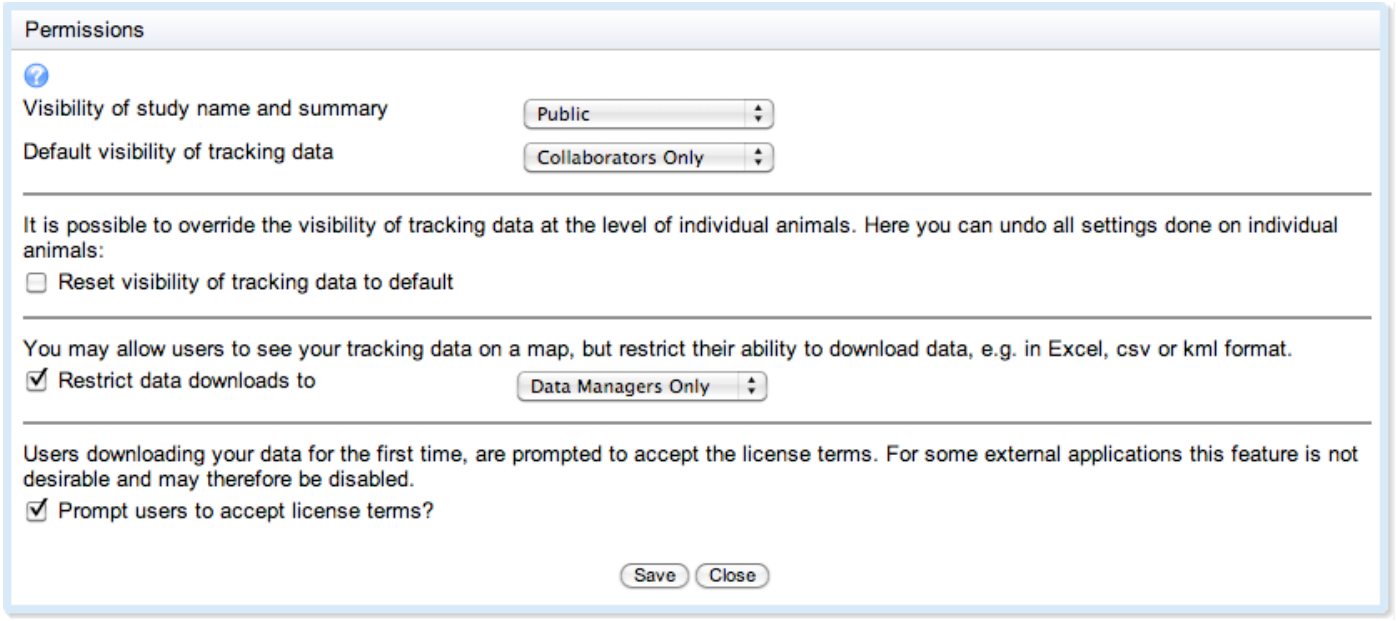
Ethische & rechtliche Aspekte

Ethische Aspekte

- **Live-Daten können Aufenthaltsorte von gefährdeten Tierarten öffentlich machen**
  - z.B. Nashörner, Wölfe, Schwarzstörche
- **Wilderer können diese Informationen ausnutzen**

Bewegungsdaten in Movebank – Rechtemanagement

- **Zugriff auf Daten in Movebank kann reguliert werden**
- **Drei Rollen**
  - Data Manager (Schreib- & Leserechte)
  - Collaborators (Leserechte)
  - Public



Bewegungsdaten in Movebank - Rechtemanagement

- **Studie kann mit Lizenz versehen werden**

Study Details

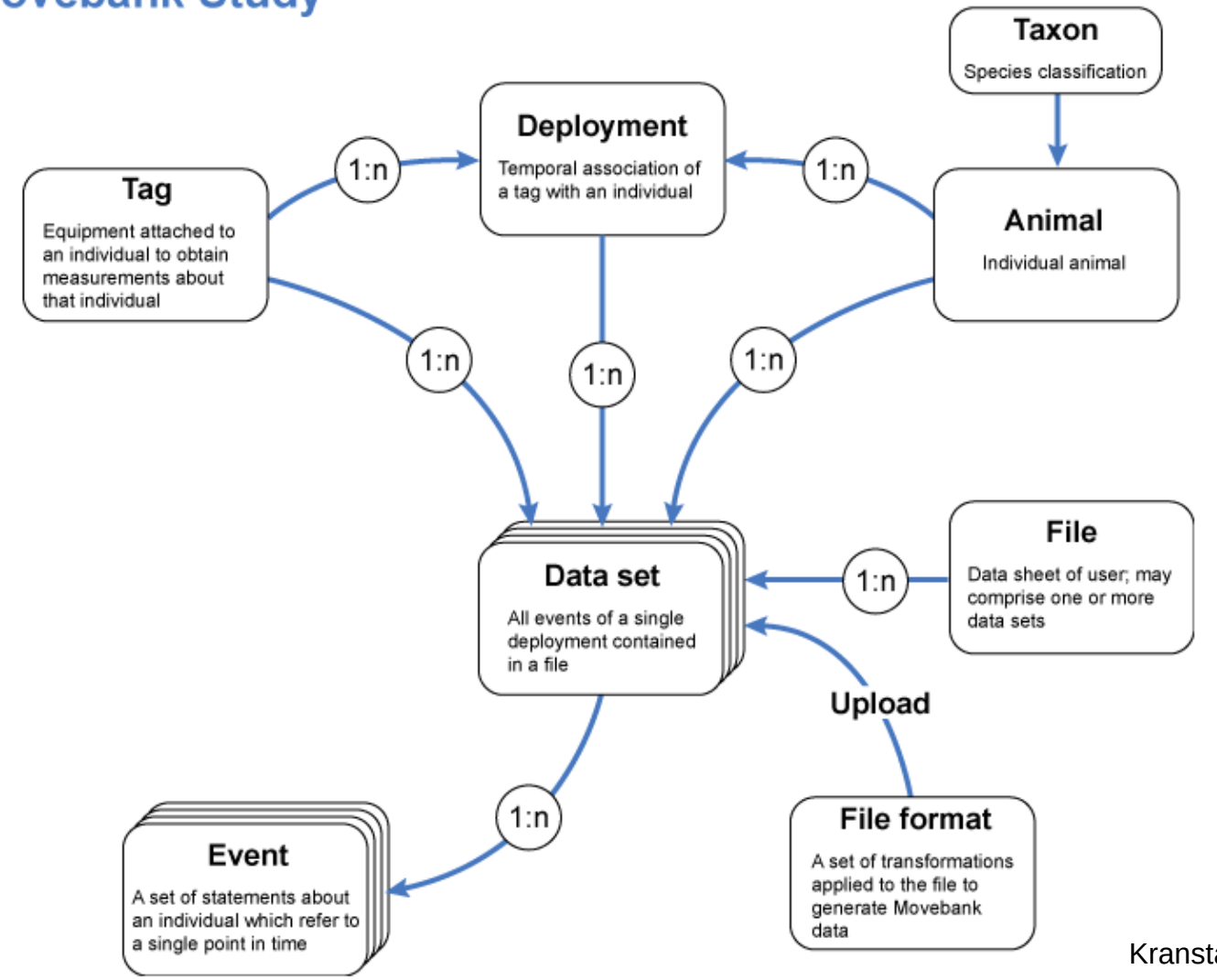
Study Name	Tsavo Lion Study
Contact Person	Brucepattersonius (Bruce Patterson)
Principal Investigator	Brucepattersonius (Bruce Patterson)
Citation	unpublished
Acknowledgements	Samuel Kasiki, Roland Kays, Alex Mwazo
Grants used	Earthwatch Institute (#5123)
License Terms	Data may be used for any academic purpose as long as you share any products, reports, or papers with Bruce Patterson bpatterson@fieldmuseum.org
Study Summary	Study the movement of lions in a natural area used by wildlife and cattle.
Study Reference Location	
Longitude	38.871
Latitude	-3.789
Movebank ID	220229
Study Statistics	Last Update > 1 year ago
Number of Animals	3
Number of Tags	4
Number of Deployments	3
Time of First Deployed Location	2002-04-27 22:04:00.000
Time of Last Deployed Location	2007-07-21 00:01:58.000
Taxa	Panthera leo
Number of Deployed Locations	2154
Number of Records	Deployed (outliers) / Total (outliers)
GPS	2154 (0) / 3619 (0)

Patterson B., 2007.
Movebank ID: 220229

Daten & Metadaten

Datenstruktur

Movebank Study



Kranstauber et al., 2011

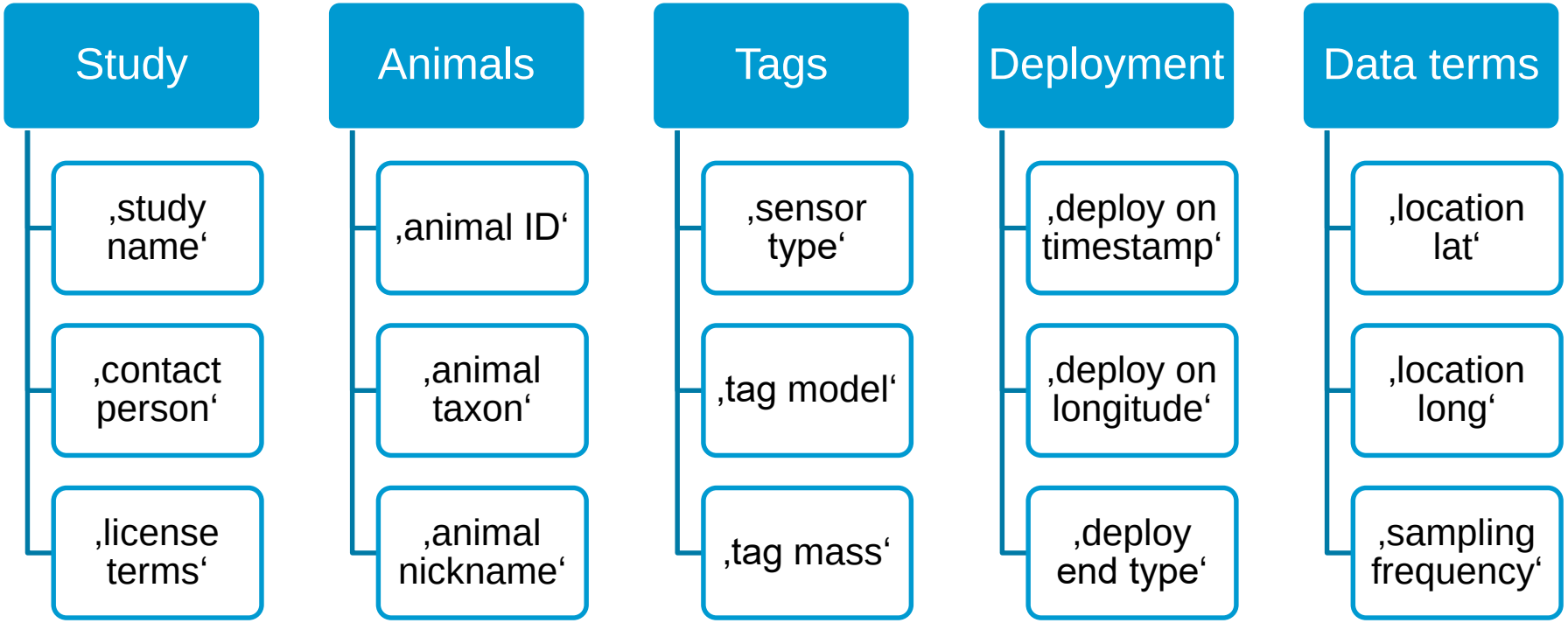
https://www.movebank.org/cms/movebank-content/mb-data-model; Abgerufen am 25.03.2020

Metadaten

- **Movebank Attribute Dictionary**
- **Attribute zu den verschiedenen Klassen des Datenschemas**
- **Vokabular persistent veröffentlicht unter:**

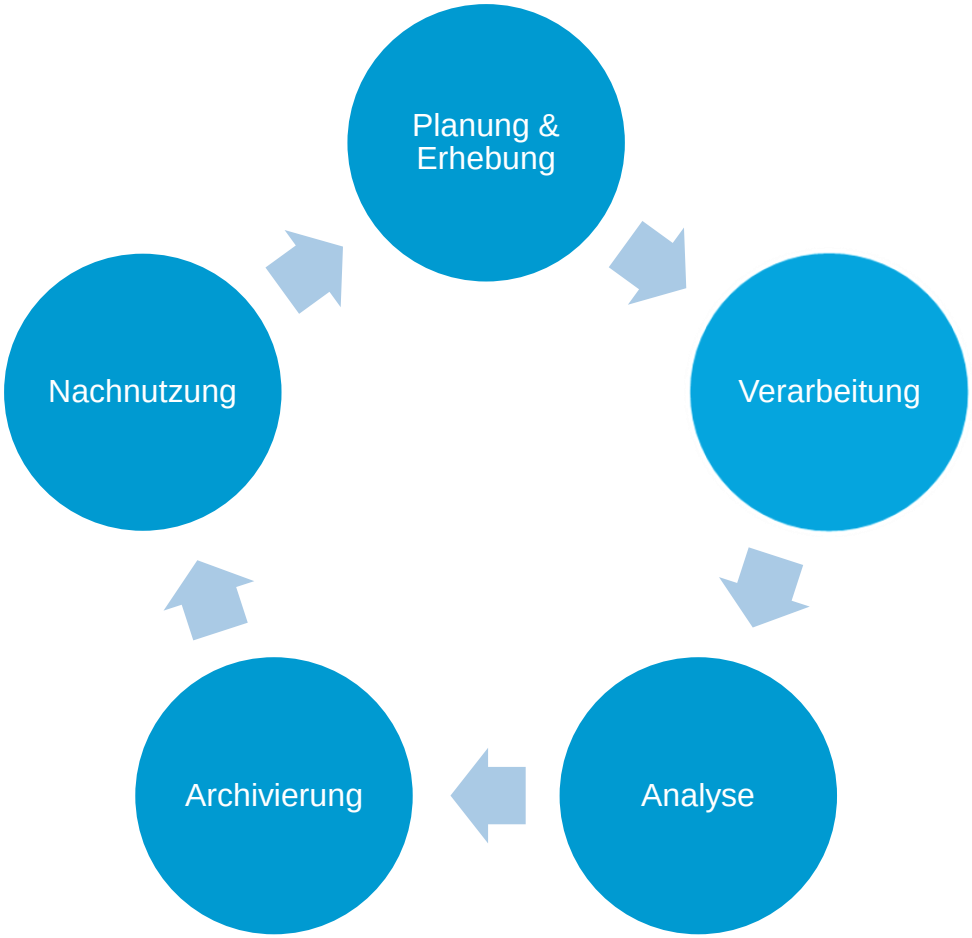
  http://vocab.nerc.ac.uk/collection/MVB/current/

Movebank Attribute Dictionary

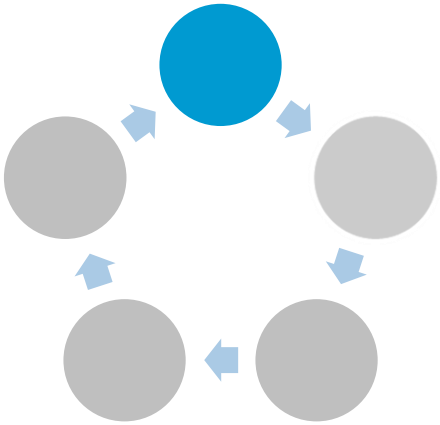


Arbeiten mit Movebank

Arbeiten mit Movebank

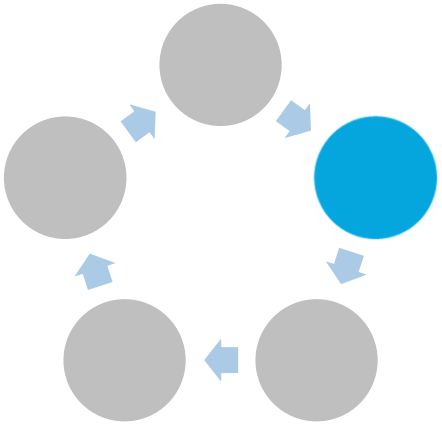


Planung & Erhebung



- **Tiere werden im Feld eingesammelt**
- **Anschließend werden sie mit Sensoren ausgestattet**
  - Wahl des Sensors
    - Unterschiedliche Technologien
    - Unterschiedliche Größe & Gewicht
- **Tiere werden frei gelassen und die Daten übertragen**
- **Sensoren müssen**
  - Daten über weite Distanzen senden
  - unter schwierigen Bedingungen funktionieren

Verarbeitung - Ingest

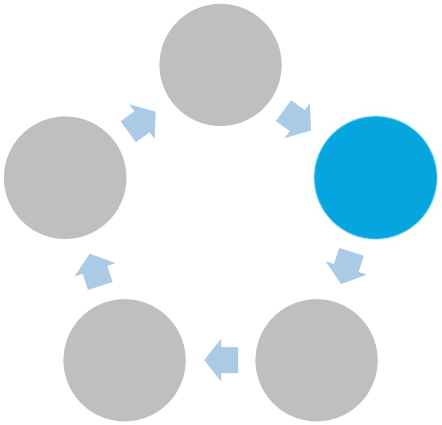


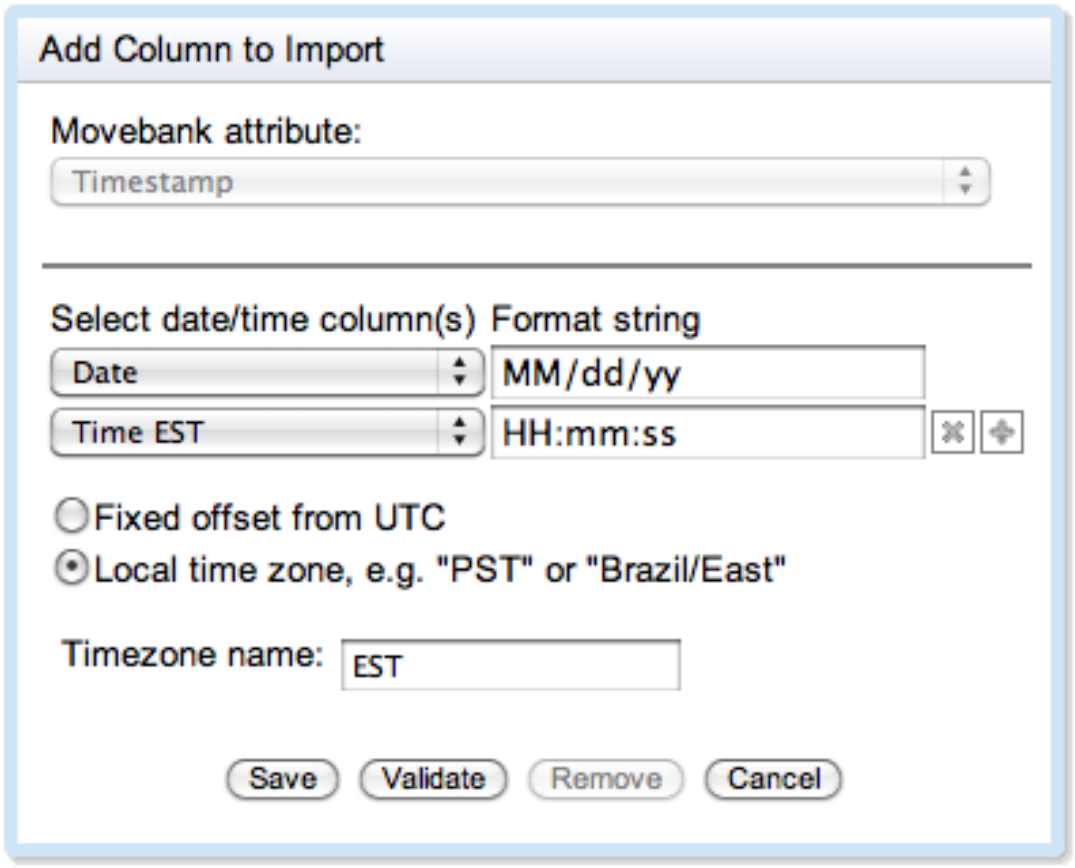
- **Ingest von Daten ins System auf zwei Wegen**
- **Import von csv/tsv-Dateien**
  - Konversion in Movebank kompatibles Schema

```
Animal,Date,Time,Latitude,Longitude
40378,31.10.03,11:26:58,14.429,31.745
40378,31.10.03,13:06:09,13.910,31.585
40378,31.10.03,16:14:24,12.964,32.032
40378,31.10.03,16:25:19,12.981,32.068
40378,01.11.03,20:12:50,10.517,33.375
40378,01.11.03,20:45:56,10.523,33.376
40378,03.11.03,04:02:41,9.179,34.095
40378,03.11.03,06:23:28,9.003,33.956
40378,03.11.03,07:16:52,8.677,34.240
```

https://www.movebank.org/cms/movebank-content/import-custom-tabular-data; Abgerufen am 25.03.2020

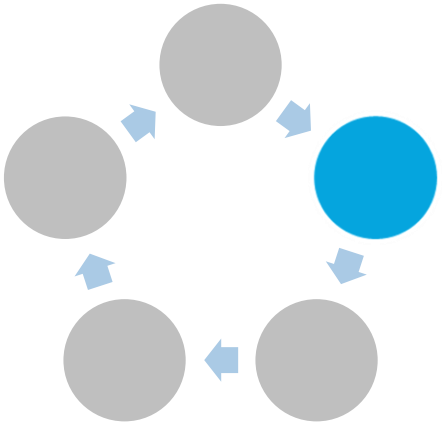
Verarbeitung - Datenkonversion

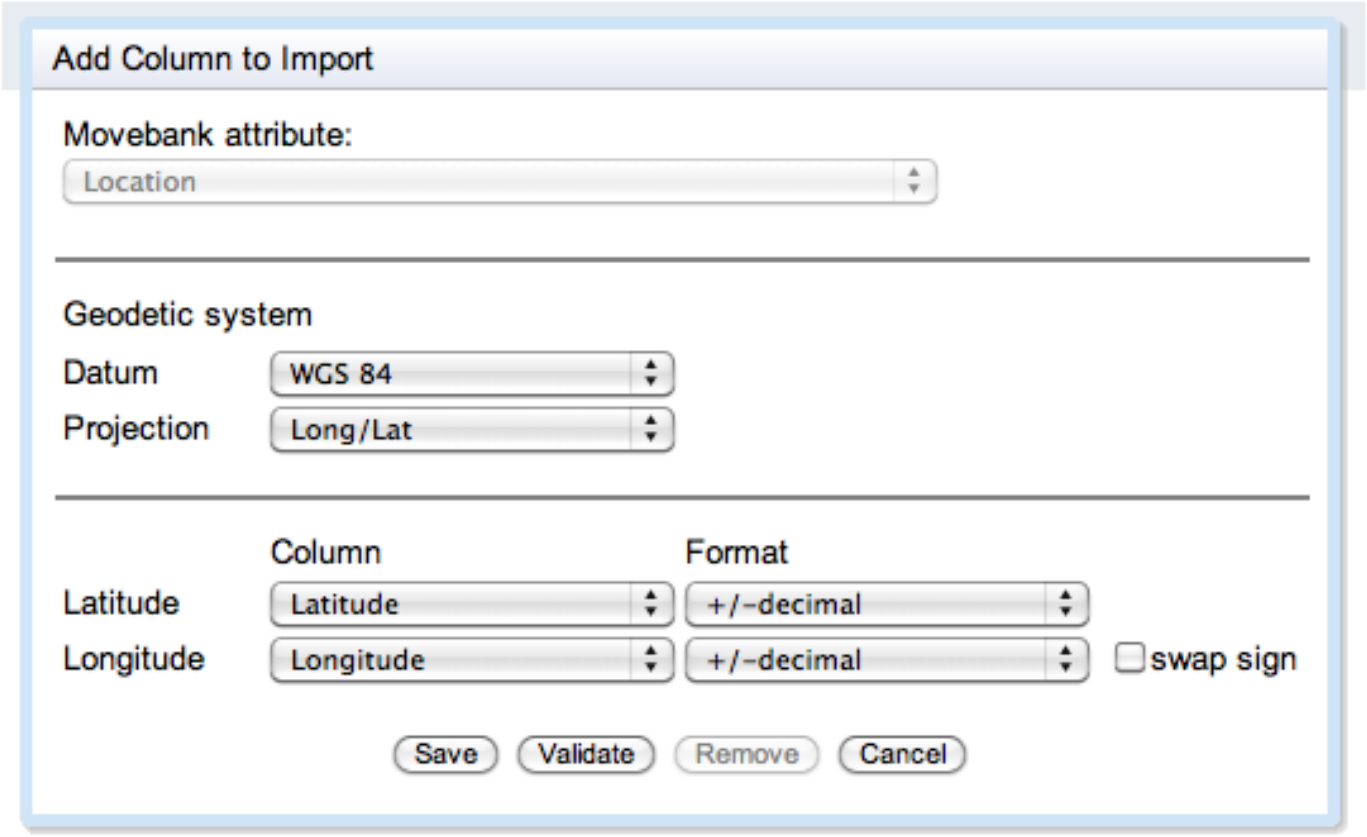




https://www.movebank.org/cms/movebank-content/import-custom-tabular-data; Abgerufen am 25.03.20

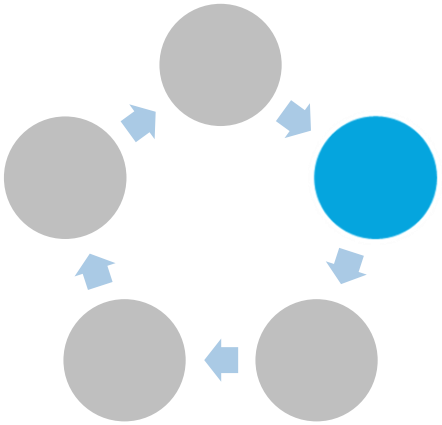
Bewegungsdaten in Movebank - Ingest

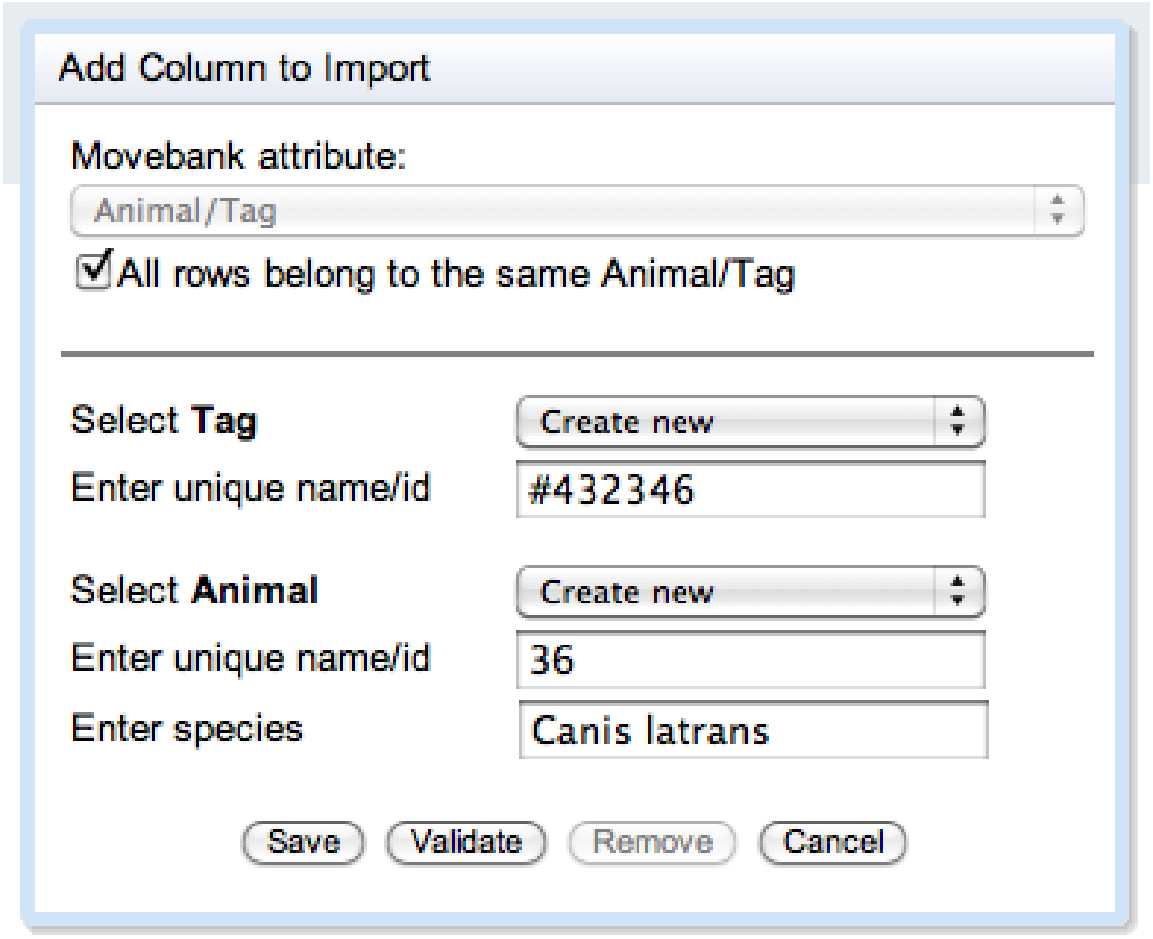




https://www.movebank.org/cms/movebank-content/import-custom-tabular-data; Abgerufen am 25.03.20

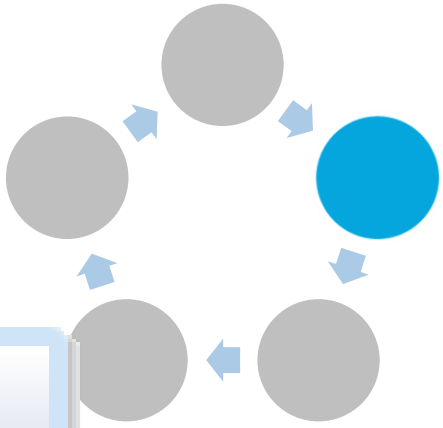
Verarbeitung - Datenkonversion

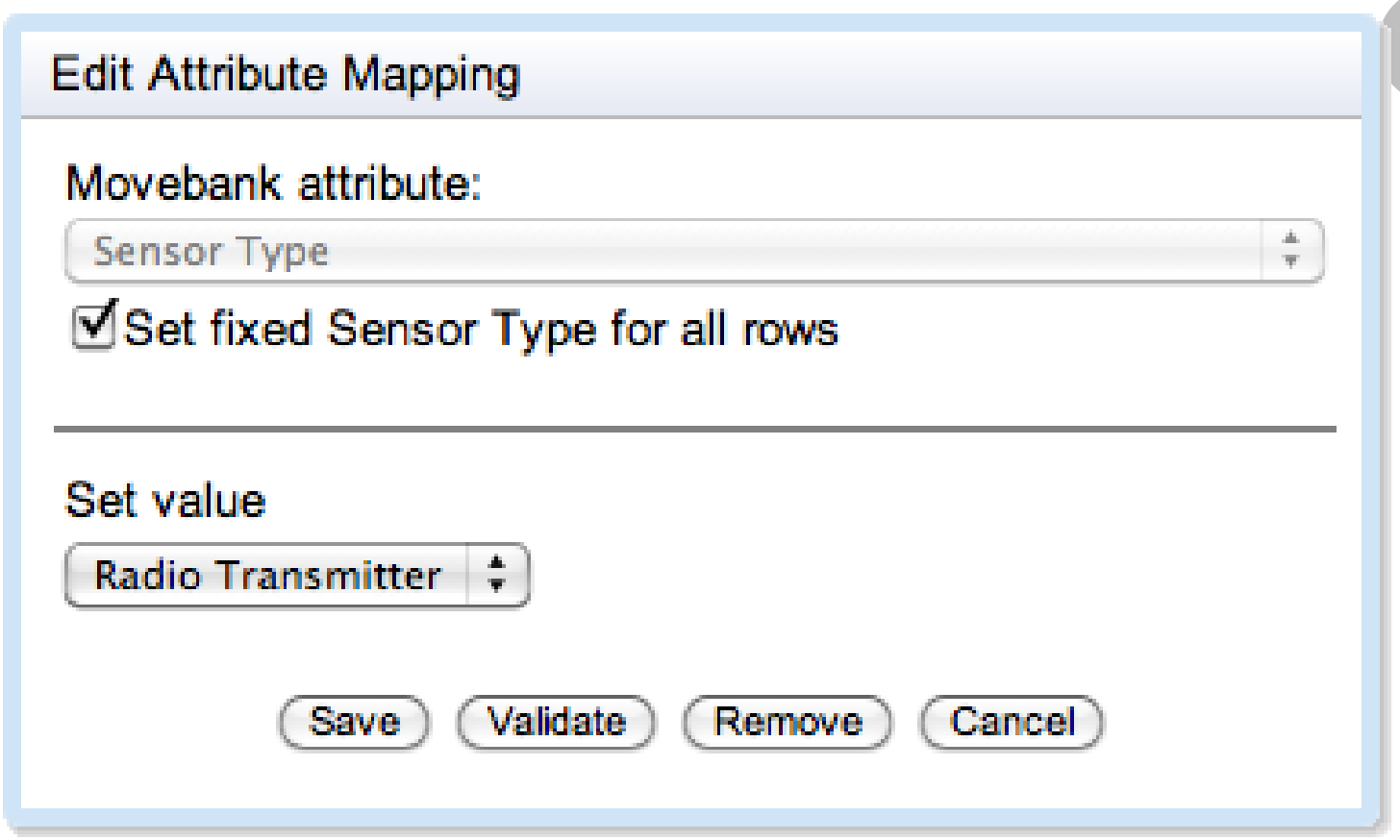




https://www.movebank.org/cms/movebank-content/import-custom-tabular-data; Abgerufen am 25.03.20

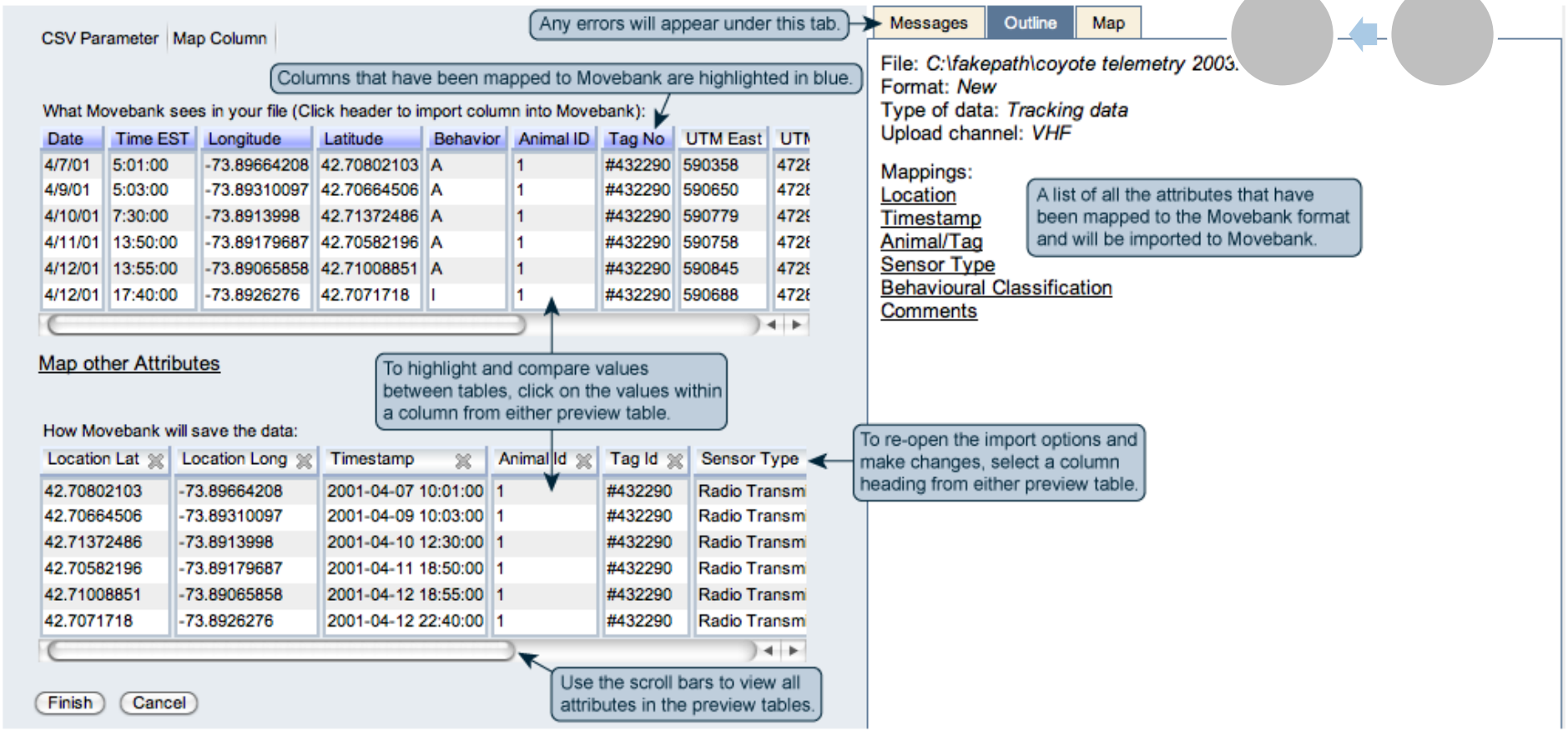
Verarbeitung - Datenkonversion





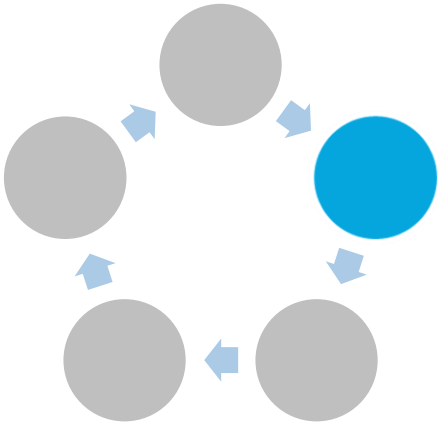
https://www.movebank.org/cms/movebank-content/import-custom-tabular-data; Abgerufen am 25.03.20

Verarbeitung - Datenkonversion



https://www.movebank.org/cms/movebank-content/import-custom-tabular-data; Abgerufen am 25.03.20

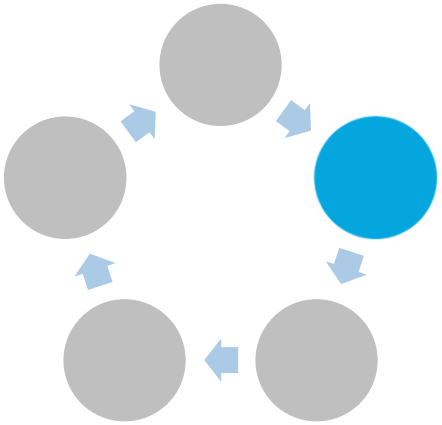
Verarbeitung – Verwendung von Live-Daten

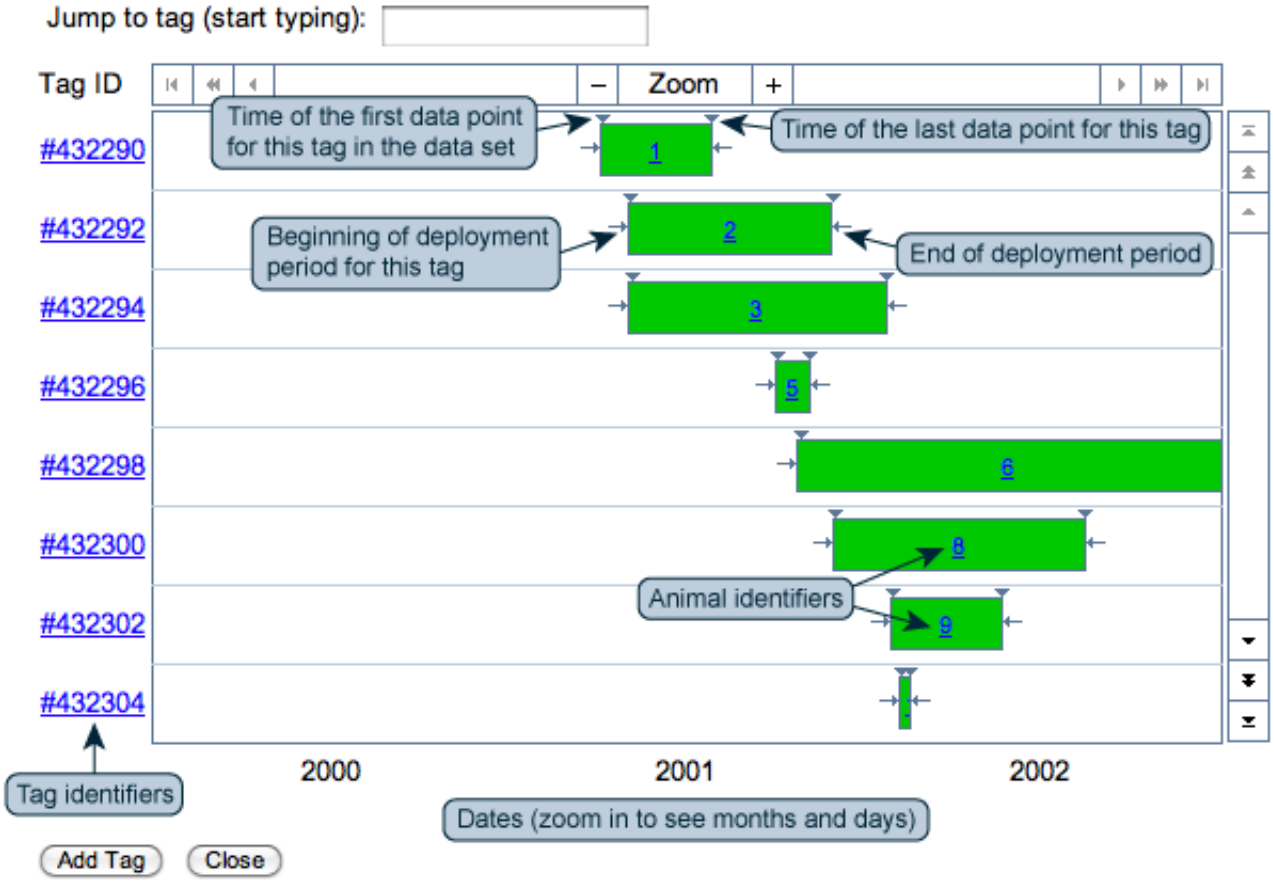


- Direkte Übertragung von Senderdaten nach Movebank
- Unterstützte Technologien:

Argos	GSM-GPS
Iridium-GPS	ICARUS

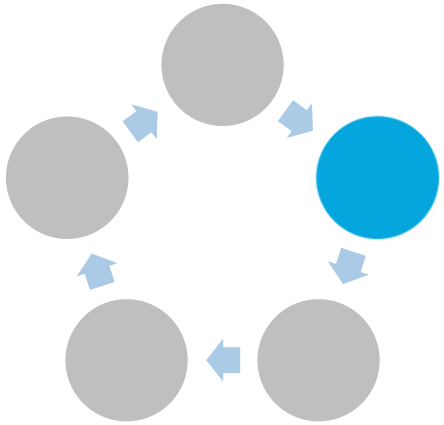
Verarbeitung – Deployment Manager

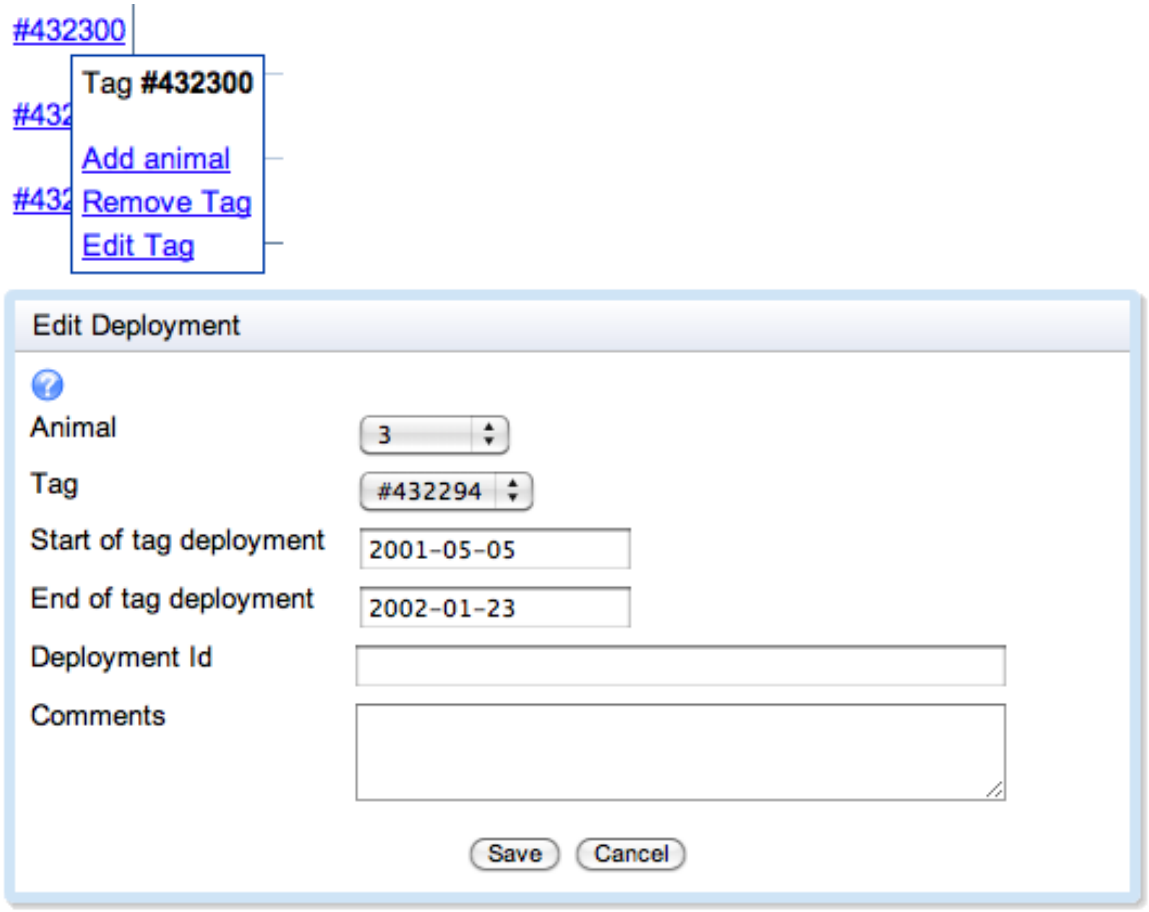




https://www.movebank.org/cms/movebank-content/deployment-manager; Abgerufen am 25.03.20

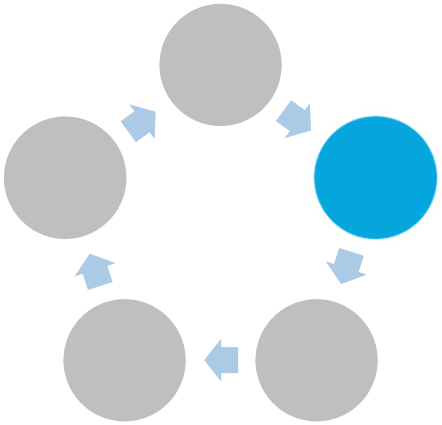
Verarbeitung – Deployment Manager

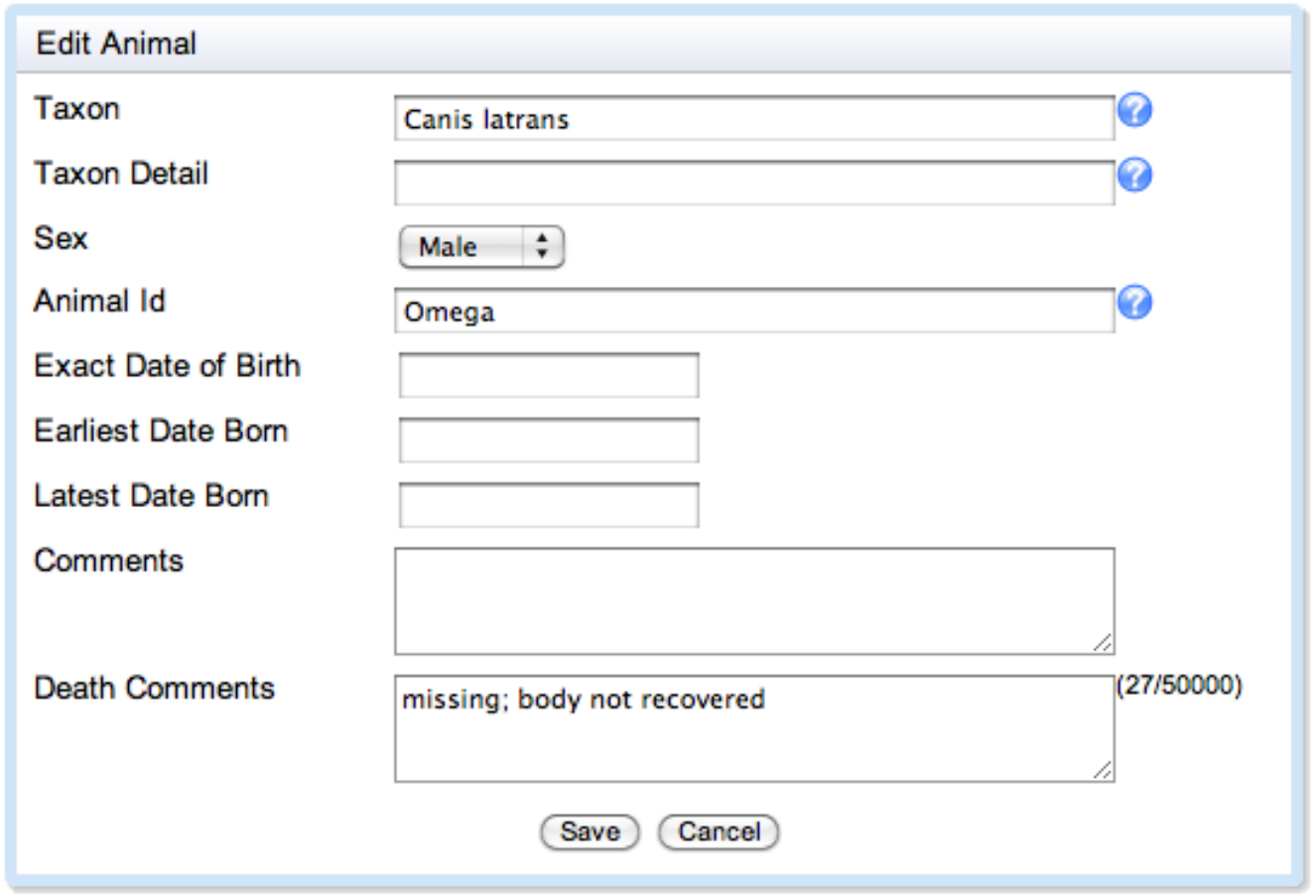




https://www.movebank.org/cms/movebank-content/deployment-manager; Abgerufen am 25.03.20

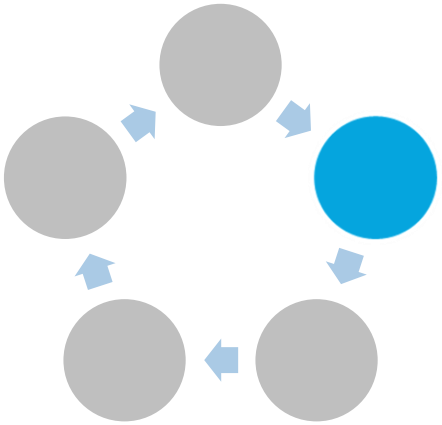
Verarbeitung – Deployment Manager

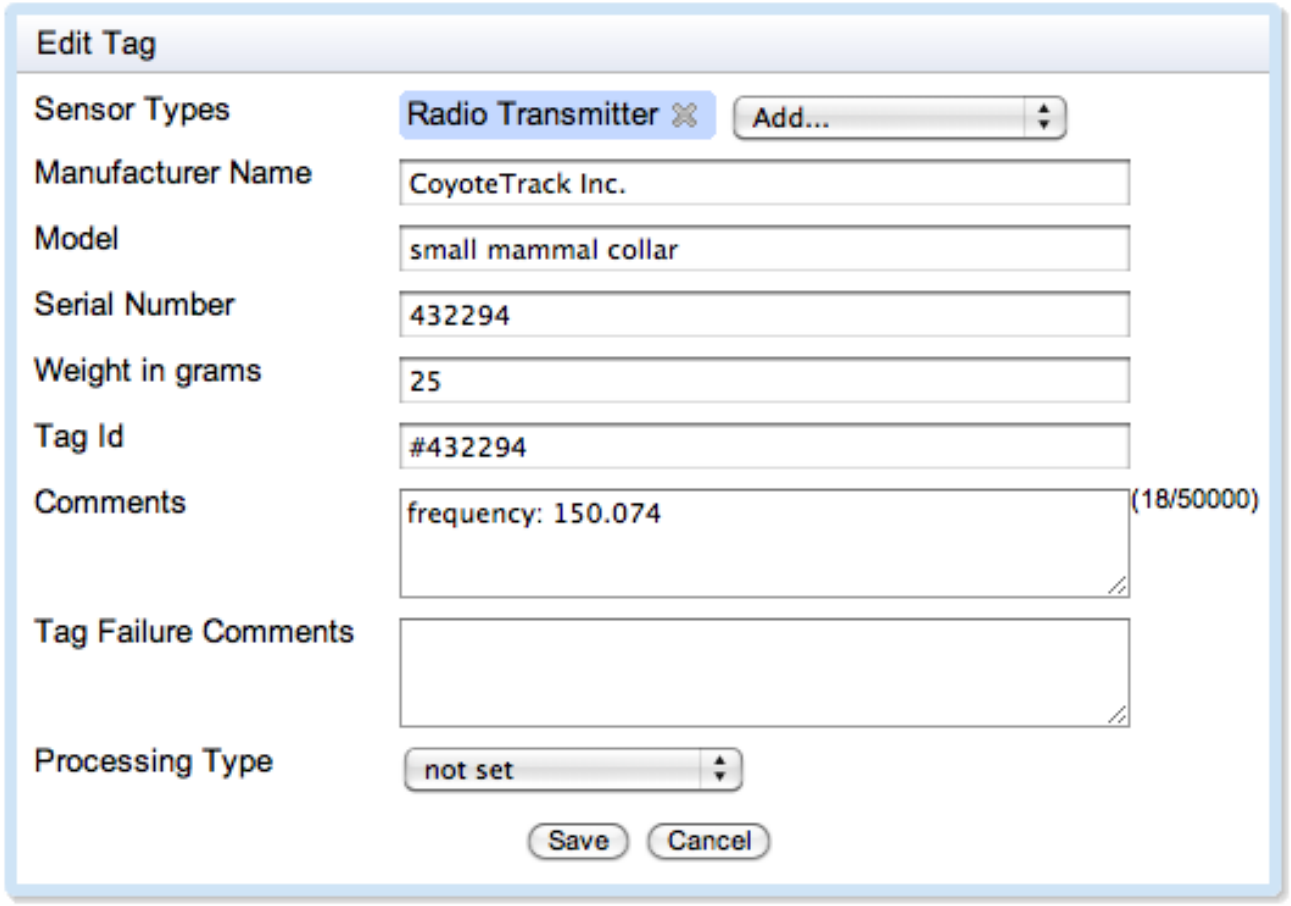




https://www.movebank.org/cms/movebank-content/deployment-manager; Abgerufen am 25.03.20

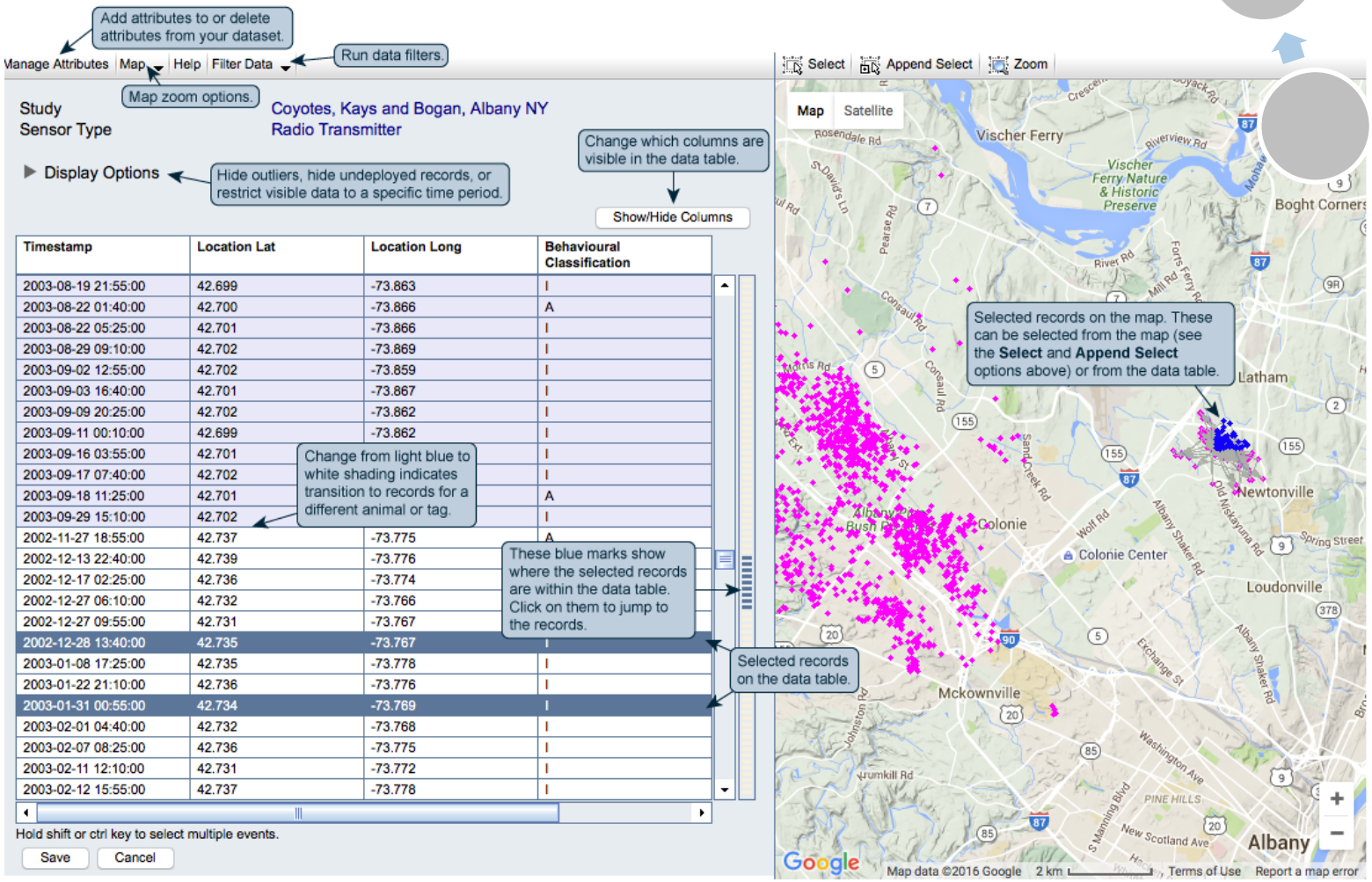
Verarbeitung – Deployment Manager





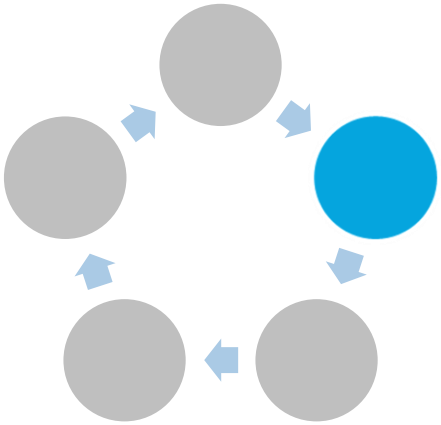
https://www.movebank.org/cms/movebank-content/deployment-manager; Abgerufen am 25.03.20

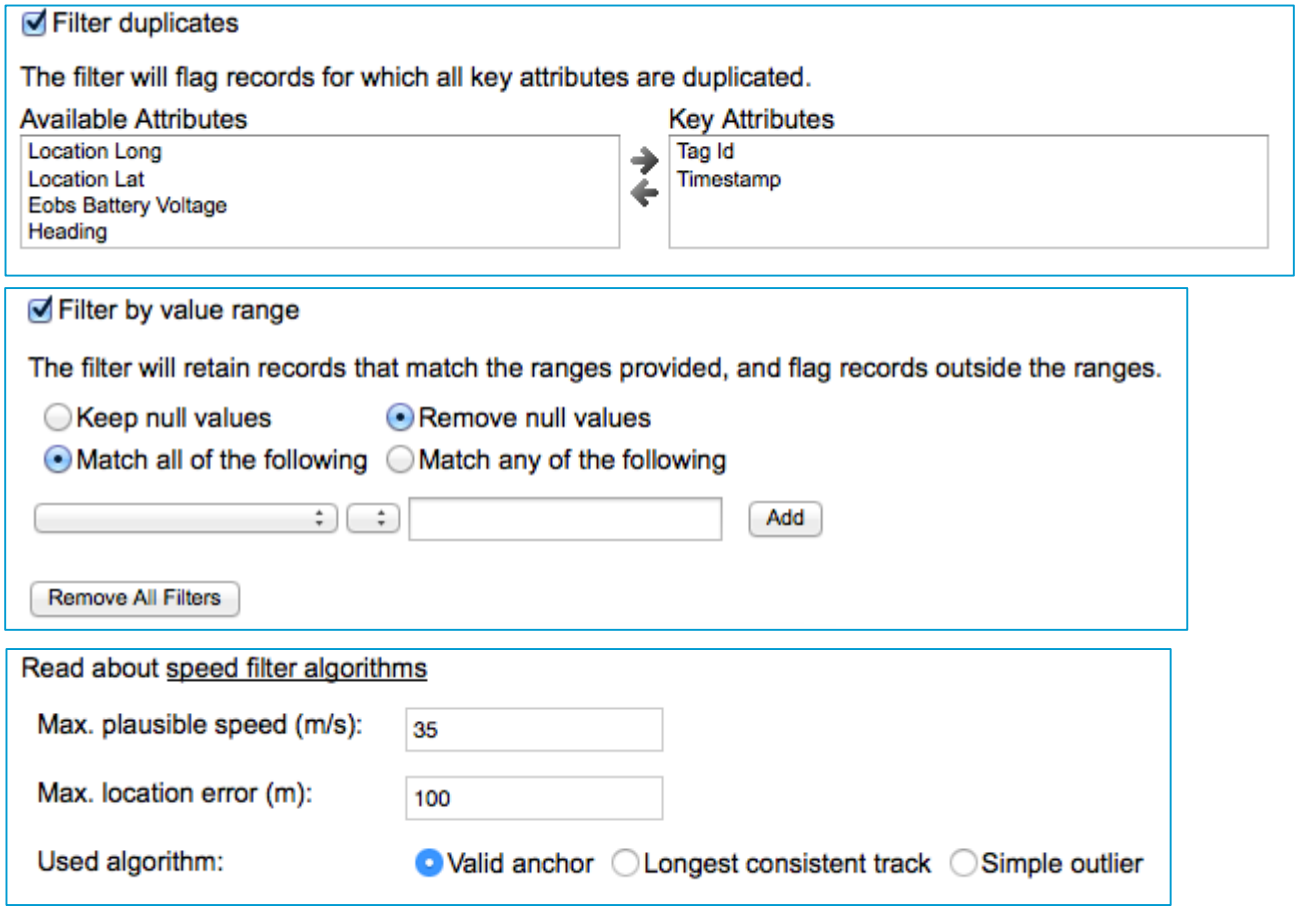
Verarbeitung – Event Editor



https://www.movebank.org/cms/movebank-content/event-editor; Abgerufen am 25.03.20

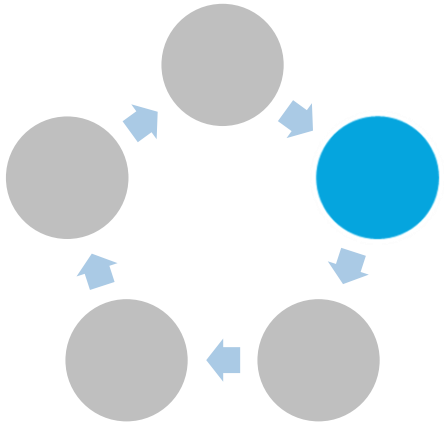
Verarbeitung – Event Editor - Filter





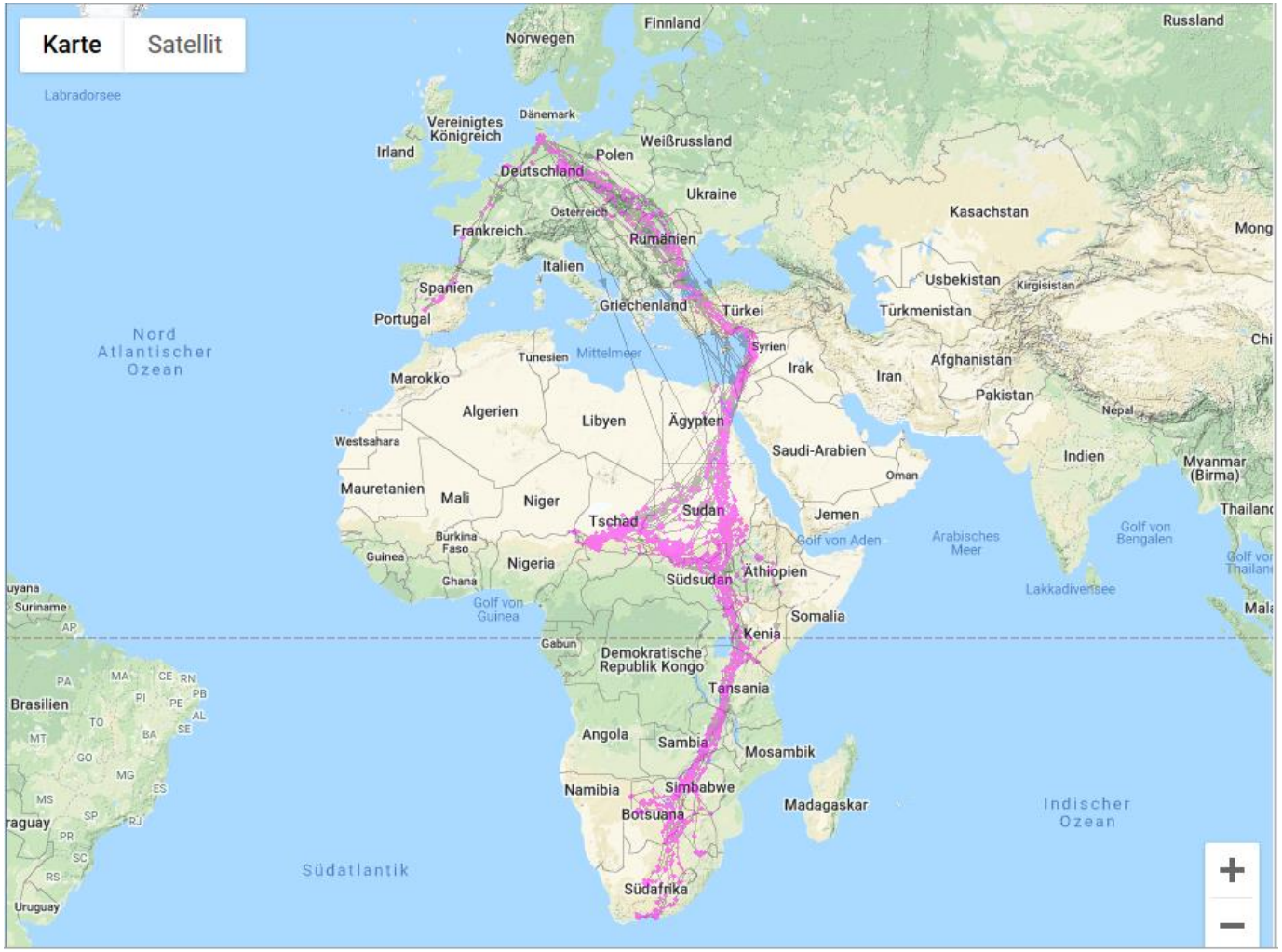
https://www.movebank.org/cms/movebank-content/general-data-filters; Abgerufen am 25.03.20

Verarbeitung – Export



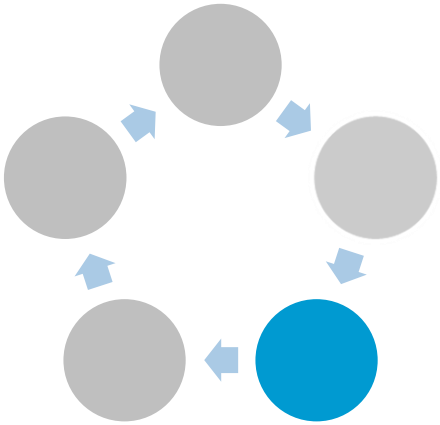
- Datenexport in verschiedene Formate
- Zugriff über REST API

Analyse – Visualisierung Storchenflug



Berthold & Kaatz, 2011.
Movebank ID 446651

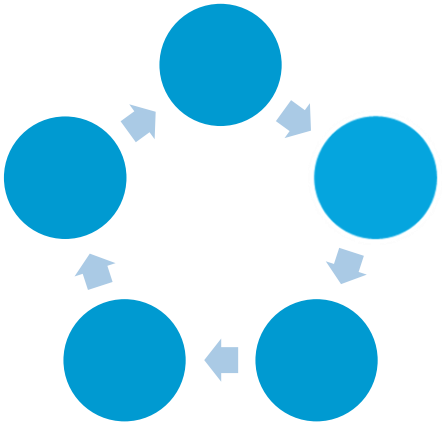
Analyse - Software



- **Diverse Software-Pakete zur Analyse von Movebank-Daten**
  - R, Java, Matlab, SciLab, etc.
- **R-Package ‚move‘**
  - Ermöglicht Zugriff auf Movebank-Daten
  - Analysefunktionen
  - Visualisierungsfunktionen
- **ENV-Data**
  - Kombination von Movebank-Daten mit Umweltdaten (Wetter, Topografie, Hydrologie etc.)

Kranstauber, Smolla & Scharf, 2019

Lehre – Open Education



- **Movebank Workshops**
- 2018 & 2019 am North Carolina Museum of Natural Sciences gehalten
  - Unterstützt durch die US National Science Foundation
- Inhalte zu Analyse von Tierbewegungsdaten
  - Statistik
  - Visualisierung
  - ENV-Data

- **AniMove Summer School**
  - Zweiwöchige Veranstaltung
  - Zielgruppe: Nachwuchswissenschaftler*innen
  - Findet seit 2013 an verschiedenen Orten statt

AniMove

http://animove.org/

Fieberg et al., 2018

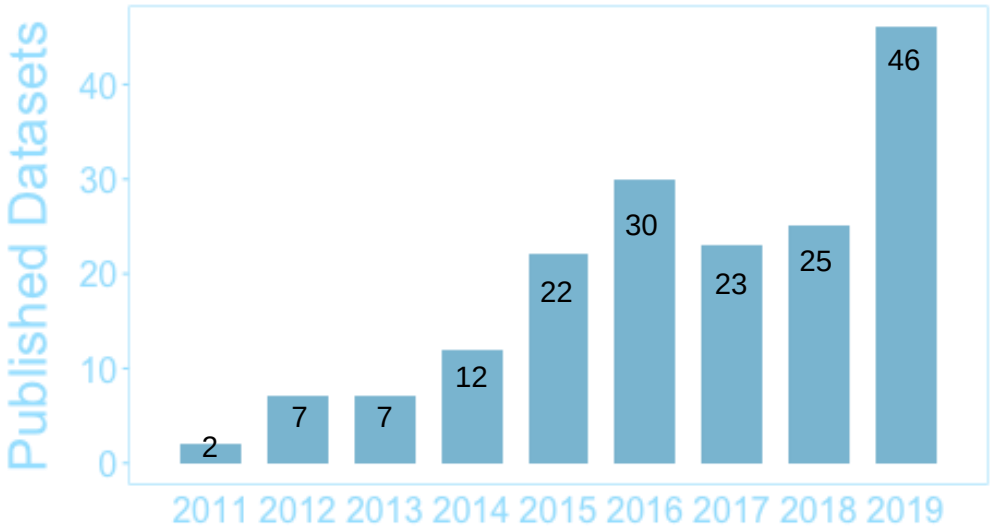
Movebank Data Repository

Zahlen & Fakten

- **Im Zuge des DFG-geförderten Projekts „MoveVRE” (2010 -2012) entstanden**
  - Betrieb seit Frühjahr 2012

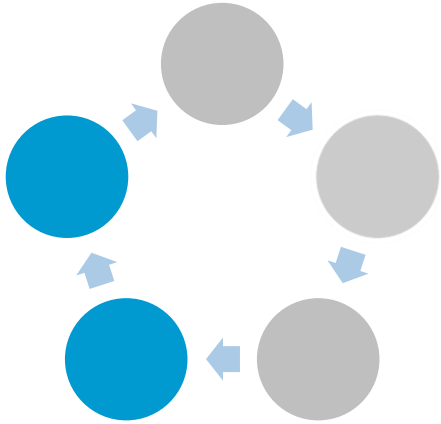
- **166 kuratierte, öffentlich archivierte Datensätze enthalten:**
  - 83 Millionen Bewegungspunkte
  - von 7971 einzelnen Tieren
  - aus 141 verschiedenen Taxa

- **Diese Datensätze sind Grundlage für:**
  - 229 Publikationen
  - in 82 Journals
  - von 528 Datenautor*innen



Stand Dezember 2019

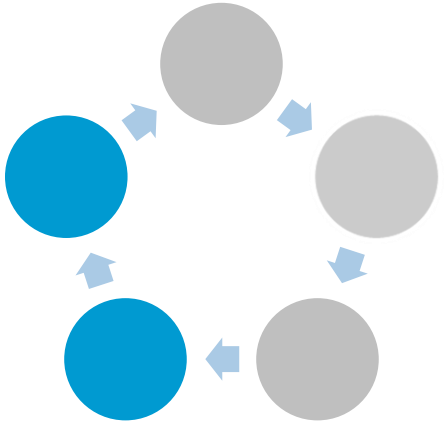
Allgemeines



- Erreichbar unter datarepository.movebank.org
- In re3data.org nachgewiesen
- Auf der Liste der Nature „Recommended Data Repositories“
- DOI-Vergabe zur persistenten Referenzierung
- Alle Datensätze sind unter CC0-Lizenz veröffentlicht
- Formale & inhaltliche Kuratierung
- Aktuell Vorbereitung auf CoreTrustSeal-Zertifizierung

https://www.movebank.org/cms/movebank-content/data-repository Abgerufen am 25.03.2020

Beispiel Datensatz - Palmenflughunde



Data from: Overall dynamic body acceleration in straw-colored fruit bats increases in headwinds but not with airspeed

When using this dataset, please cite the original article.

O'Mara MT, Scharf AK, Fahr J, Abedi-Lartey M, Wikelski M, Dechmann DKN, Safi K (2019) Overall dynamic body acceleration in straw-colored fruit bats increases in headwinds but not with airspeed. Frontiers in Ecology and Evolution. doi:10.3389/fevo.2019.00200

Additionally, please cite the Movebank data package:

Scharf AK, Fahr J, Abedi-Lartey M, Safi K, Dechmann DKN, Wikelski M, O'Mara MT (2019) Data from: Overall dynamic body acceleration in straw-colored fruit bats increases in headwinds but not with airspeed. Movebank Data Repository. doi:10.5441/001/1.k8n02jn8

Cite | Share

Package Identifier doi:10.5441/001/1.k8n02jn8

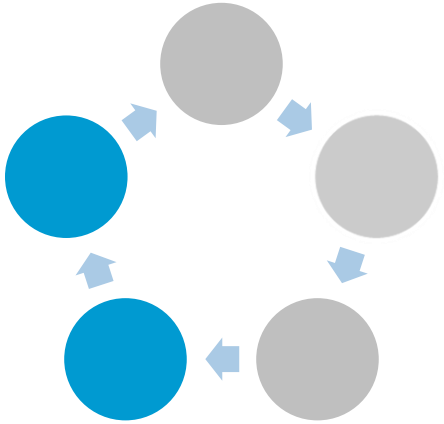
Abstract

Atmospheric conditions impact how animals use the aerosphere, and birds and bats should modify their flight to minimise energetic expenditure relative to changing wind conditions. To investigate how free-ranging straw-colored fruit bats (Eidolon helvum) fly with changing wind support, we use data collected from bats fit with GPS loggers and an integrated triaxial accelerometer and measure flight speeds, wingbeat frequency, and overall dynamic body acceleration (ODBA) as an estimate for energetic expenditure. We predicted that if ODBA reflects energetic expenditure, then we should find a curvilinear relationship between ODBA and airspeed consistent with aerodynamic theory. We expected that bats would lower their airspeed with tailwind support and that ODBA will decrease with increasing tailwinds and increase with wingbeat frequency. We found that wingbeat frequency has the strongest positive relationship with ODBA. There was a small, but negative, relationship between airspeed and ODBA, and bats decreased ODBA with increasing tailwind. Bats flew at ground speeds of 9.6 ± 2.4 ms-1 (mean ± sd, range: 4.3 to 23.9 ms-1) and airspeeds of 10.2 ± 2.5 ms-1, and did not modify their wingbeat frequency with speed. Free-ranging straw-colored fruit bats therefore exerted more total ODBA in headwinds but not when they changed their airspeed. It is possible that the flexibility in wingbeat kinematics may make flight of free-ranging bats less costly than currently predicted or alternatively that the combination of ODBA and airspeed at our scales of measurement does not reflect this relationship in straw-colored fruit bats. Further work is needed to understand the full potential of free-ranging bat flight and how well bio-logging techniques reflect the costs of bat flight.

Keywords animal movement, animal tracking, avian migration, biotelemetry, body acceleration, Burkina Faso, Eidolon helvum, flight behavior, Ghana, GPS logger, straw-colored fruit bat, Zambia,

dx.doi.org/10.5441/001/1.k8n02jn8

Beispiel Datensatz - Palmenflughunde



Data from: Overall dynamic body acceleration in straw-colored fruit bats increases in headwinds but not with airspeed

When using this dataset, please cite the original article

O'Mara MT, Scharf AK, Fahr J, Abedi-Lartey M, Wikelski M, Dechmann DKN, Safi K (2019) Overall dynamic body acceleration in straw-colored fruit bats increases in headwinds but not with airspeed. Frontiers in Ecology and Evolution. doi:10.3389/fevo.2019.00200

Additionally, please cite the Movebank data package:

Scharf AK, Fahr J, Abedi-Lartey M, Safi K, Dechmann DKN, Wikelski M, O'Mara MT (2019) Data from: Overall dynamic body acceleration in straw-colored fruit bats increases in headwinds but not with airspeed. Movebank Data Repository. doi:10.5441/001/1.k8n02jn8

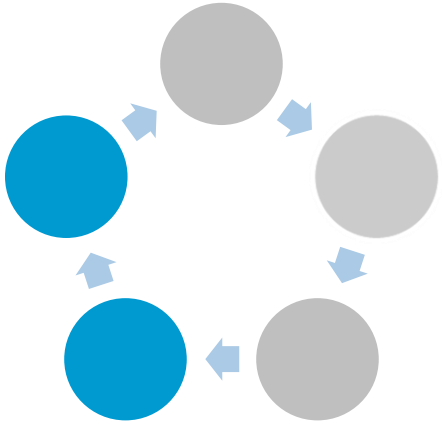
Cite | Share

CC ZERO

Package Identifier	doi:10.5441/001/1.k8n02jn8
Abstract	Atmospheric conditions impact how animals use the aerosphere, and birds and bats should modify their flight to minimise energetic expenditure relative to changing wind conditions. To investigate how free-ranging straw-colored fruit bats (Eidolon helvum) fly with changing wind support, we use data collected from bats fit with GPS loggers and an integrated triaxial accelerometer and measure flight speeds, wingbeat frequency, and overall dynamic body acceleration (ODBA) as an estimate for energetic expenditure. We predicted that if ODBA reflects energetic expenditure, then we should find a curvilinear relationship between ODBA and airspeed consistent with aerodynamic theory. We expected that bats would lower their airspeed with tailwind support and that ODBA will decrease with increasing tailwinds and increase with wingbeat frequency. We found that wingbeat frequency has the strongest positive relationship with ODBA. There was a small, but negative, relationship between airspeed and ODBA, and bats decreased ODBA with increasing tailwind. Bats flew at ground speeds of 9.6 ± 2.4 ms-1 (mean ± sd, range: 4.3 to 23.9 ms-1) and airspeeds of 10.2 ± 2.5 ms-1, and did not modify their wingbeat frequency with speed. Free-ranging straw-colored fruit bats therefore exerted more total ODBA in headwinds but not when they changed their airspeed. It is possible that the flexibility in wingbeat kinematics may make flight of free-ranging bats less costly than currently predicted or alternatively that the combination of ODBA and airspeed at our scales of measurement does not reflect this relationship in straw-colored fruit bats. Further work is needed to understand the full potential of free-ranging bat flight and how well bio-logging techniques reflect the costs of bat flight.
Keywords	animal movement, animal tracking, avian migration, biotelemetry, body acceleration, Burkina Faso, Eidolon helvum, flight behavior, Ghana, GPS logger, straw-colored fruit bat, Zambia,

dx.doi.org/10.5441/001/1.k8n02jn8

Beispiel Datensatz - Palmenflughunde



Straw-colored fruit bats (Eidolon helvum) in Africa 2009-2014-gps View File Details

Download: README.txt (18.56Kb)
Download: Straw-colored fruit bats (Eidolon helvum) in Africa 2009-2014-gps.csv (4.497Mb)

To the extent possible under law, the authors have waived all copyright and related or neighboring rights to this data. (cc) ZERO

Straw-colored fruit bats (Eidolon helvum) in Africa 2009-2014-acc View File Details

Download: README.txt (18.56Kb)
Download: Straw-colored fruit bats (Eidolon helvum) in Africa 2009-2014-acc.csv (1.250Gb)

To the extent possible under law, the authors have waived all copyright and related or neighboring rights to this data. (cc) ZERO

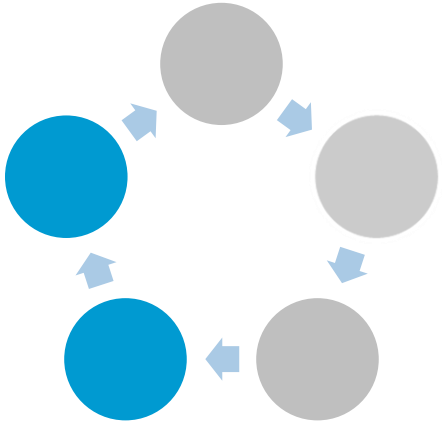
Straw-colored fruit bats (Eidolon helvum) in Africa 2009-2014-reference-data View File Deta

Download: README.txt (18.56Kb)
Download: Straw-colored fruit bats (Eidolon helvum) in Africa 2009-2014-reference-data.csv (23.28Kb)

To the extent possible under law, the authors have waived all copyright and related or neighboring rights to this data. (cc) ZERO

dx.doi.org/10.5441/001/1.k8n02jn8

Struktur Datensätze

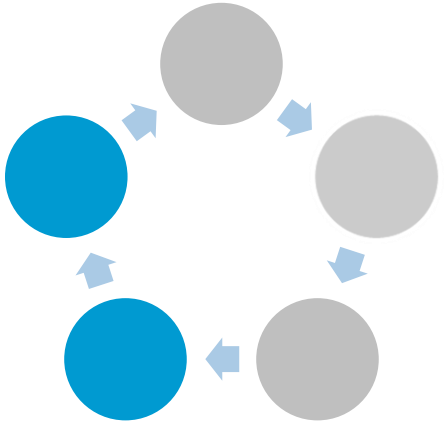


Bewegungsdaten

Referenzdaten

Readme

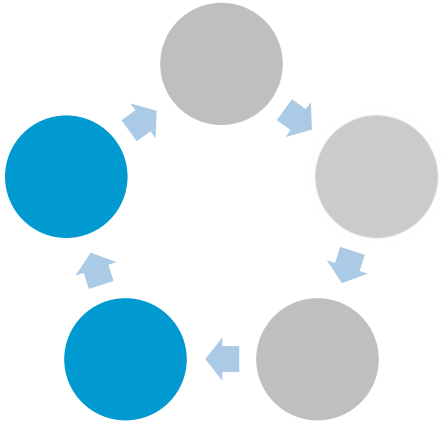
Beispiel Bewegungsdaten - Palmenflughunde



1	event-id	visible	timestamp	location-long	location-lat	eobs:battery-voltage	tag-local-identifier
2	4867397312	true	10.08.2013 18:58:31	-1,4972975	12,3828987	4208	1617
3	4867397313	true	10.08.2013 19:00:09	-1,4970394	12,38287	4204	1617
4	4867397314	true	10.08.2013 19:30:14	-1,4975039	12,3830343	4208	1617
5	4867397315	true	10.08.2013 20:00:54	-1,4977117	12,3833251	4204	1617
6	4867397316	true	10.08.2013 20:19:06			4204	1617
7	4867397317	true	10.08.2013 20:30:43	-1,4985502	12,3831154	4199	1617
8	4867397318	true	10.08.2013 21:00:28	-1,4990864	12,3831537	4194	1617
9	4867397319	true	10.08.2013 21:18:09	-1,4987144	12,3830616	4189	1617
10	4867397320	true	10.08.2013 21:20:11	-1,4984254	12,3835163	4189	1617
11	4867397321	true	10.08.2013 21:22:51	-1,4985618	12,3835698	4184	1617
12	4867397322	true	10.08.2013 21:27:40	-1,5016195	12,3741868	4189	1617
13	4867397323	true	10.08.2013 21:30:11	-1,5018975	12,3680004	4184	1617
14	4867397324	true	10.08.2013 21:33:09	-1,5025731	12,3674001	4179	1617

dx.doi.org/10.5441/001/1.k8n02jn8

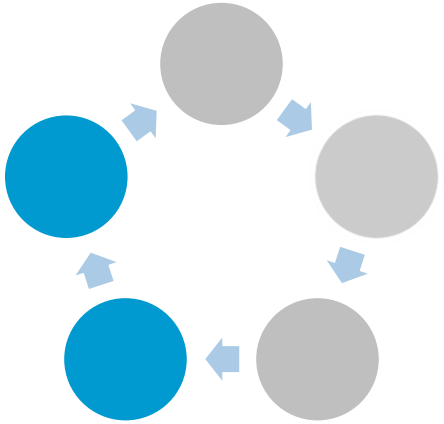
Beispiel Bewegungsdaten - Palmenflughunde



1	event-id	visible	timestamp	location-long	location-lat	eobs:battery-voltage	tag-local-identifier
2	4867397312	true	10.08.2013 18:58:31	-1,4972975	12,3828987	4208	1617
3	4867397313	true	10.08.2013 19:00:09	-1,4970394	12,38287	4204	1617
4	4867397314	true	10.08.2013 19:30:14	-1,4975039	12,3830343	4208	1617
5	4867397315	true	10.08.2013 20:00:54	-1,4977117	12,3833251	4204	1617
6	4867397316	true	10.08.2013 20:19:06			4204	1617
7	4867397317	true	10.08.2013 20:30:43	-1,4985502	12,3831154	4199	1617
8	4867397318	true	10.08.2013 21:00:28	-1,4990864	12,3831537	4194	1617
9	4867397319	true	10.08.2013 21:18:09	-1,4987144	12,3830616	4189	1617
10	4867397320	true	10.08.2013 21:20:11	-1,4984254	12,3835163	4189	1617
11	4867397321	true	10.08.2013 21:22:51	-1,4985618	12,3835698	4184	1617
12	4867397322	true	10.08.2013 21:27:40	-1,5016195	12,3741868	4189	1617
13	4867397323	true	10.08.2013 21:30:11	-1,5018975	12,3680004	4184	1617
14	4867397324	true	10.08.2013 21:33:09	-1,5025731	12,3674001	4179	1617

dx.doi.org/10.5441/001/1.k8n02jn8

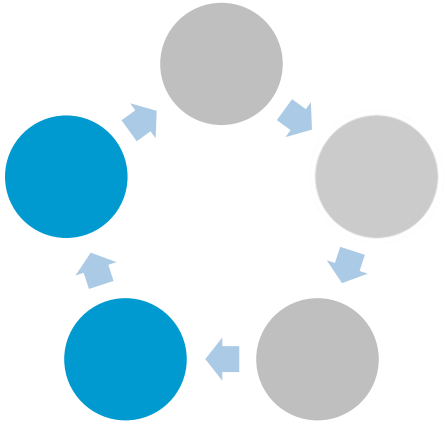
Beispiel Referenzdaten - Palmenflughunde



	tag-id	animal-id	animal-taxon	deploy-on-date	deploy-off-date	animal-comments	animal-life-s	animal-mass
2	1079	1079	Eidolon helvum	2009-08-26 18:09:01.000	2009-08-29 04:40:37.000	forearm length: 118.1 mm	adult	284.0
3	1080	1080	Eidolon helvum	2009-08-26 18:09:25.000	2009-08-28 05:50:38.000	forearm length: 113.9 mm	adult	244.0
4	1081	1081	Eidolon helvum	2009-08-26 18:29:16.000	2009-08-29 05:50:36.000	forearm length: 123.5 mm	adult	274.0
5	1082	1082	Eidolon helvum	2009-08-27 18:40:56.000	2009-08-28 05:50:17.000	forearm length: 120 mm	adult	246.0
6	1084	1084	Eidolon helvum	2009-08-28 18:13:24.000	2009-08-31 22:45:43.000	forearm length: 115.1 mm	adult	239.0
7	1086	1086	Eidolon helvum	2009-08-28 18:24:49.000	2009-08-30 05:45:42.000	forearm length: 118.2 mm	adult	277.0
8	1088	1088	Eidolon helvum	2009-08-28 18:34:08.000	2009-08-30 05:55:31.000	forearm length: 120 mm	adult	247.0
9	1626	1626	Eidolon helvum	2011-02-02 05:56:00.000	2011-02-04 17:56:00.000	forearm length: 119.1 mm	adult	280.0
10	1607	1607	Eidolon helvum	2011-02-03 06:02:00.000	2011-02-09 11:42:00.000	forearm length: 124.7 mm	adult	321.0
11	1613	1613	Eidolon helvum	2011-02-03 06:26:00.000	2011-02-04 10:41:00.000	forearm length: 123.4 mm	adult	305.0
12	1616	1616	Eidolon helvum	2011-02-05 05:09:00.000	2011-02-07 09:30:00.000	forearm length: 121 mm	adult	292.0

dx.doi.org/10.5441/001/1.k8n02jn8

Dokumentation Datensätze



- **Readme-Datei enthält:**
  - Umfangsbeschreibung des Datensatzes
  - Zitationsangabe für den Datensatz
  - Referenz zu Publikationen, die auf dem Datensatz basieren
  - Lizenzhinweis (CC0)
  - Erläuterung der im Datensatz verwendeten Attribute

Ziel: langfristige Nachnutzbarkeit der Daten

Movebank 2.0

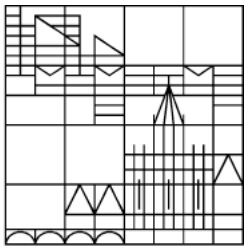
Movebank 2.0

Baden-Württemberg

MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST

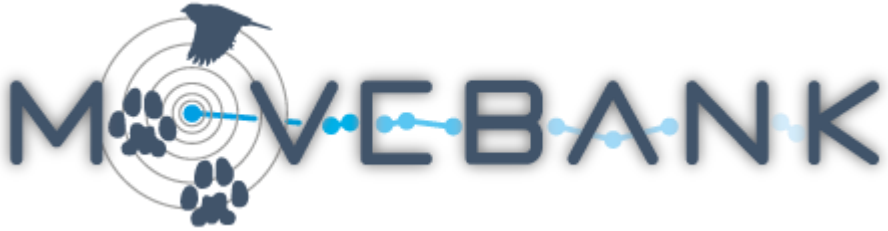
MAX-PLANCK-GESELLSCHAFT

Universität Konstanz



- **Laufzeit: 01.06.2019 – 31.05.2023**

Ziele des Projekts



- Erweiterung von Movebank für neue Sensortechnologien
- Entwicklung von Analysesoftware zur Visualisierung & Exploration der Daten
- Einbeziehung von Bürgerwissenschaftler*innen
- Unterstützung der Open-Source-Community bei der Entwicklung von Analysewerkzeugen
- Ausbau der AniMove Summer School & Bereitstellung von E-Learning-Angeboten

Erweiterung der Metadaten

- **Neue Sensoren erheben neue Arten von Daten**
  - z.B. Beschleunigung, Gravitation, Lichtintensität etc.
- **Anreicherung der Daten mit Citizen Science-Inhalten**
  - Drohnenaufnahmen, Videos, Audio, etc.
- **Movebank Attribute Dictionary muss erweitert werden**

ICARUS

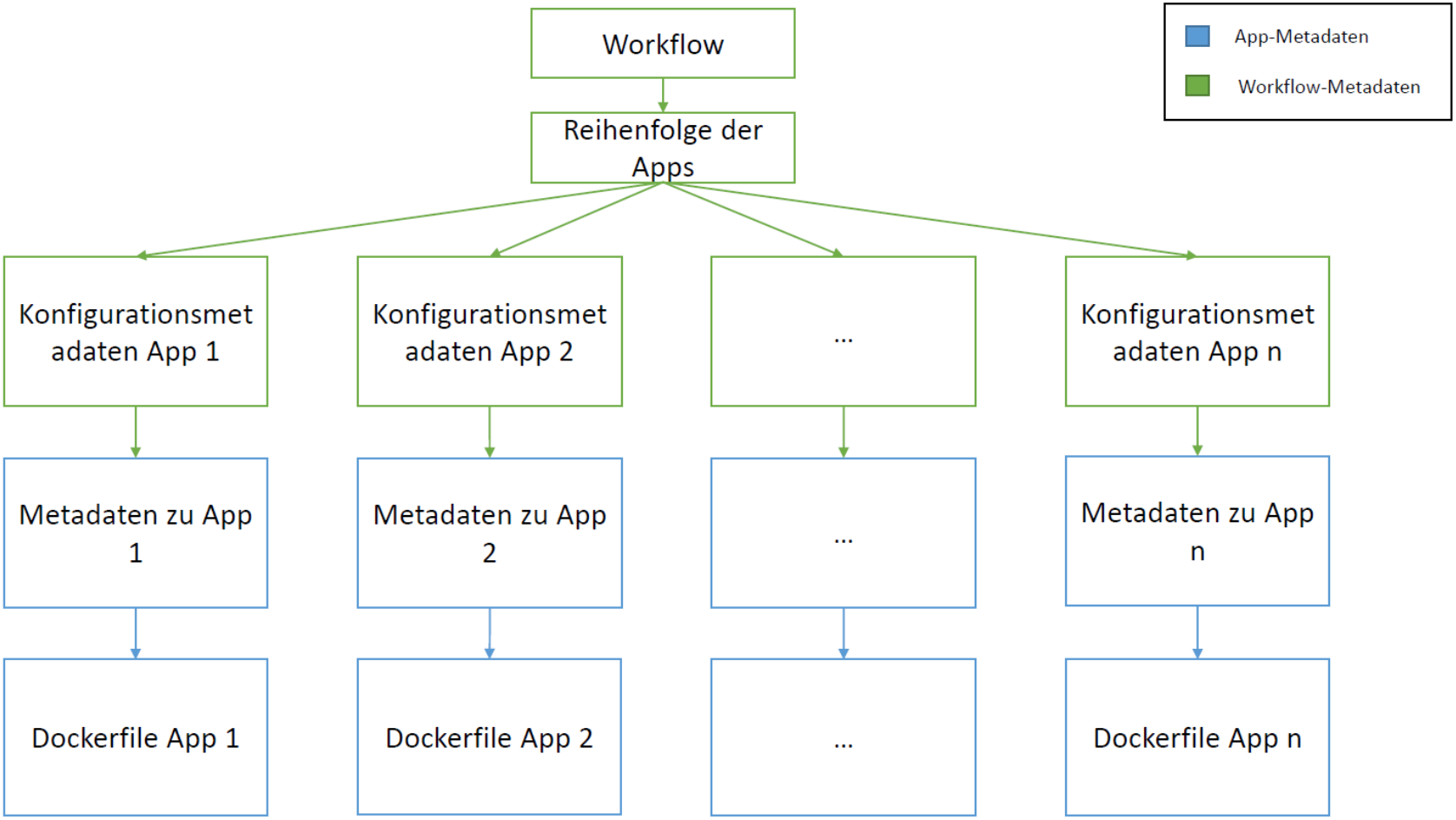
MaxPlanckSociety, 2019
https://www.youtube.com/watch?v=e_KNyhQMjOY; Abgerufen am 25.03.2020

MoveStore Metadatenschema

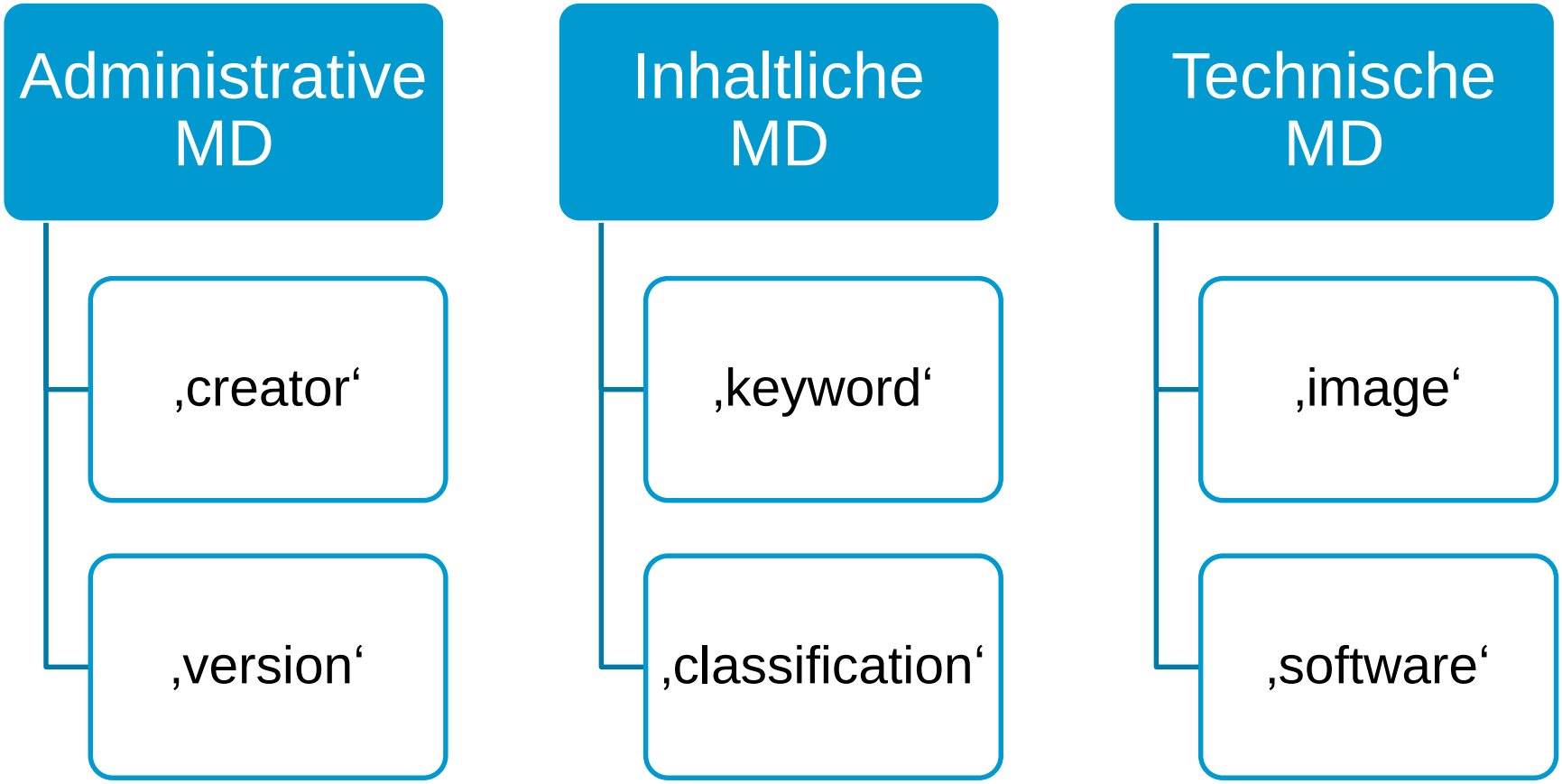
- **MoveStore**
  - Plattform zur Entwicklung- & Veröffentlichung von Analysewerkzeugen für Movebank-Daten
  - Unterstützung der Open-Source-Community
  - Einzelne Software-Anwendungen sollen als Apps bereitgestellt werden
  - Möglichkeit der modularen Kombination von Apps zu Workflows
- **Apps & Workflows sollen persistent gespeichert & referenziert werden können**

- **Entwurf eines Metadatenschemas zur persistenten Speicherung der Apps und Workflows**

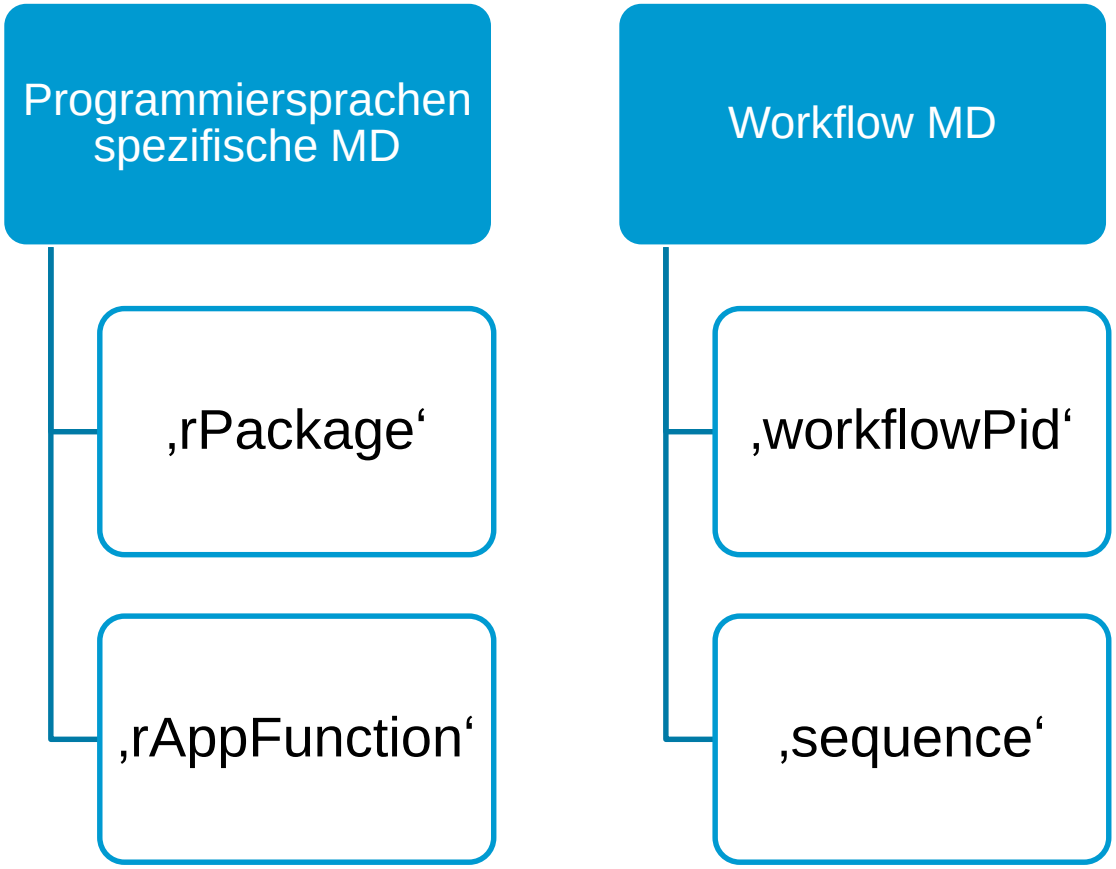
MoveStore Metadatenschema - Konzept



MoveStore Metadatenschema



MoveStore Metadatenschema



MoveStore Metadatenschema

- rPackageLabel
- rPackageVersion
- rPackageURI
- rPackageLicense

Aufzeichnung AniMove & e-Learning

http://animove.org/

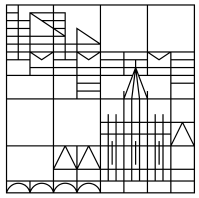
- **Aufzeichnung der AniMove Summer School**
  - 07.09. – 18.09. am MPI für Verhaltensbiologie in Radolfzell
  - Begrenzte Teilnehmer*innen-Kapazität
  - Großes Interesse → Aufnahme der Veranstaltung durch das KIM Lecture Recording-Team
- **Beitrag zum Thema Forschungsdatenmanagement zur Summer School**
- **Entwurf & Bereitstellung von E-Learning im Bereich Forschungsdatenmanagement**

Kooperationsmöglichkeiten für Infrastruktureinrichtungen

Kooperationsmöglichkeiten für Infrastruktureinrichtungen

- **Bibliotheken als Spezialisten für die Klassifizierung digitaler Objekte**
  - → Unterstützung beim Entwurf von Datenstrukturen und Metadatenschemata
- **Kompetenz im Forschungsdatenmanagement**
  - → Beratung und Dienstleistungen für die Planung, Durchführung und Sicherung von Forschungsvorhaben
- **Erfahrung in Softwareentwicklung & Anforderungsmanagement**
  - → Unterstützung von Projektpartnern mit externen Dienstleistern
- **Partner mit Einbindung in langfristig bestehende Institutionen**
  - → Möglichkeit des Aufbaus von langfristig betreibbaren Infrastrukturen
- **Erfahrung im Bereich Informationsvermittlung**
  - → Konzeption & Durchführung von spezifisch zugeschnittenen Schulungen

Universität Konstanz



Herzlichen Dank!

Gabriel Schneider & Dr. Elisabeth Böker
Team Open Science · KIM Universität Konstanz

kim.uni-konstanz.de
gabriel.schneider@uni-konstanz.de
elisabeth.boeker@uni-konstanz.de

Quellen

- AniMove. http://animove.org/
- Berthold P & Kaatz M (2011) MPIO White Stork Argos. Verfügbar in Movebank unter der Movebank ID: 446651.
- Fieberg J, Bohrer G, Davidson SC, Kays R (2018) Short course on analyzing animal tracking data. Presented at the North Carolina Museum of Natural Sciences, Raleigh, NC, USA. May 21–23, 2018. https://movebankworkshopraleighnc.netlify.com/index.html. Abgerufen am 25.03.2020.
- Kranstauber B, Smolla M, Scharf A (2019) move: Visualizing and Analyzing Animal Track Data. Version 3.2.2 . Verfügbar unter: https://CRAN.R-project.org/package=move. Agerufen am 25.03.2020.
- Kranstauber B, Cameron A, Weinzerl R, Fountain T, Tilak S, Wikelski M, Kays R (2011) The Movebank data model for animal tracking. https://doi.org/10.1016/j.envsoft.2010.12.005.
- MaxPlanckSociety (2018) Flugverhalten von Störchen in der Thermik. https://www.youtube.com/watch?v=RRq-panAKME. Abgerufen am 25.03.2020.

Quellen

- MaxPlanckSociety (2019) Icarus initiative: Wildlife Observation from Space. https://www.youtube.com/watch?v=e_KNyhQMjOY. Abgerufen am 25.03.2020.
- Movebank. https://www.movebank.org/. Abgerufen am 25.03.2020.
- Movebank (2017) Global animal movements based on Movebank data (map). https://youtu.be/nUKh0fr1Od8 Abgerufen am 25.03.2020.
- Movebank Data Repository. https://www.datarepository.movebank.org/ Abgerufen am 25.03.2020.
- O'Mara MT, Scharf AK, Fahr J, Abedi-Lartey M, Wikelski M, Dechmann DKN, Safi K (2019) Overall dynamic body acceleration in straw-colored fruit bats increases in headwinds but not with airspeed. Frontiers in Ecology and Evolution. doi:10.3389/fevo.2019.00200.
- Patterson, B (2007) Tsavo Lion Study. Verfügbar in Movebank unter der Movebank ID: 220229.