

# Wireless Remote Animal Monitoring (WRAM)



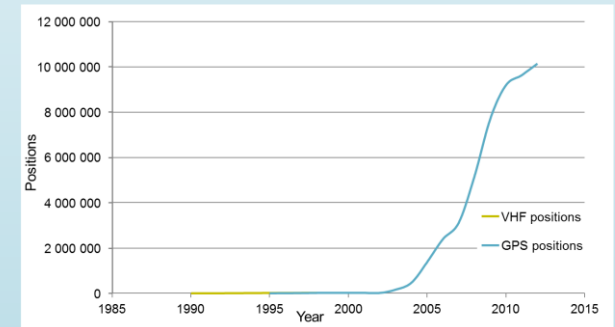
The national Swedish biotelemetry  
database e-infrastructure for sensor  
data from animals

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Remote Animal Monitoring  
(UC-WRAM)  
Dept. of Wildlife, Fish, and  
Environm. Studies  
SLU Umeå, Sweden

# WRAM History

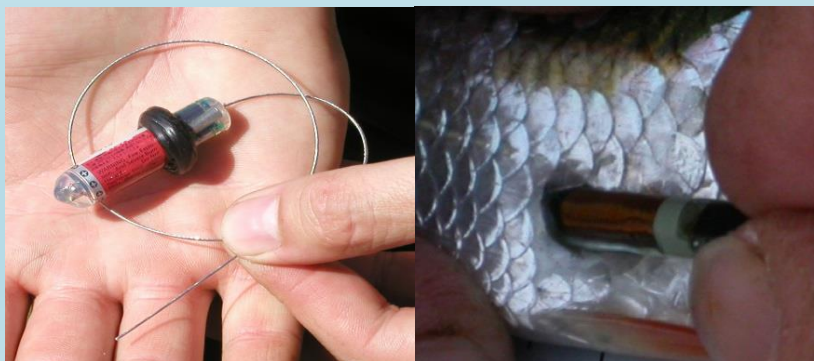
- Started in 2003 as local database
- Realtime monitoring of 25 moose with GPS-GSM collars
- Exponential growth since then
- Upgrade 2011-2014 into the Swedish National Infrastructure WRAM
- Funded by the Swedish Research Council



# WRAM – Our mission

## (Inter-)National e-Infrastructure:

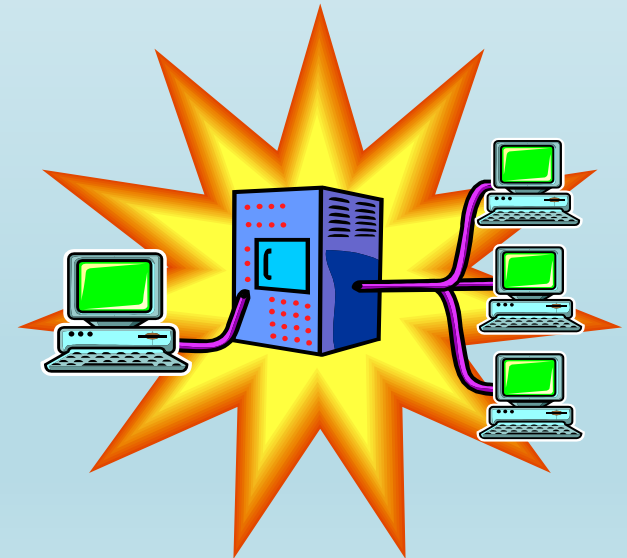
- Universal database **network**
- Automatically capture, store, share, and analyze
- Biotelemetry sensor data
- From animals  
(fish, wildlife, domesticated, ...)



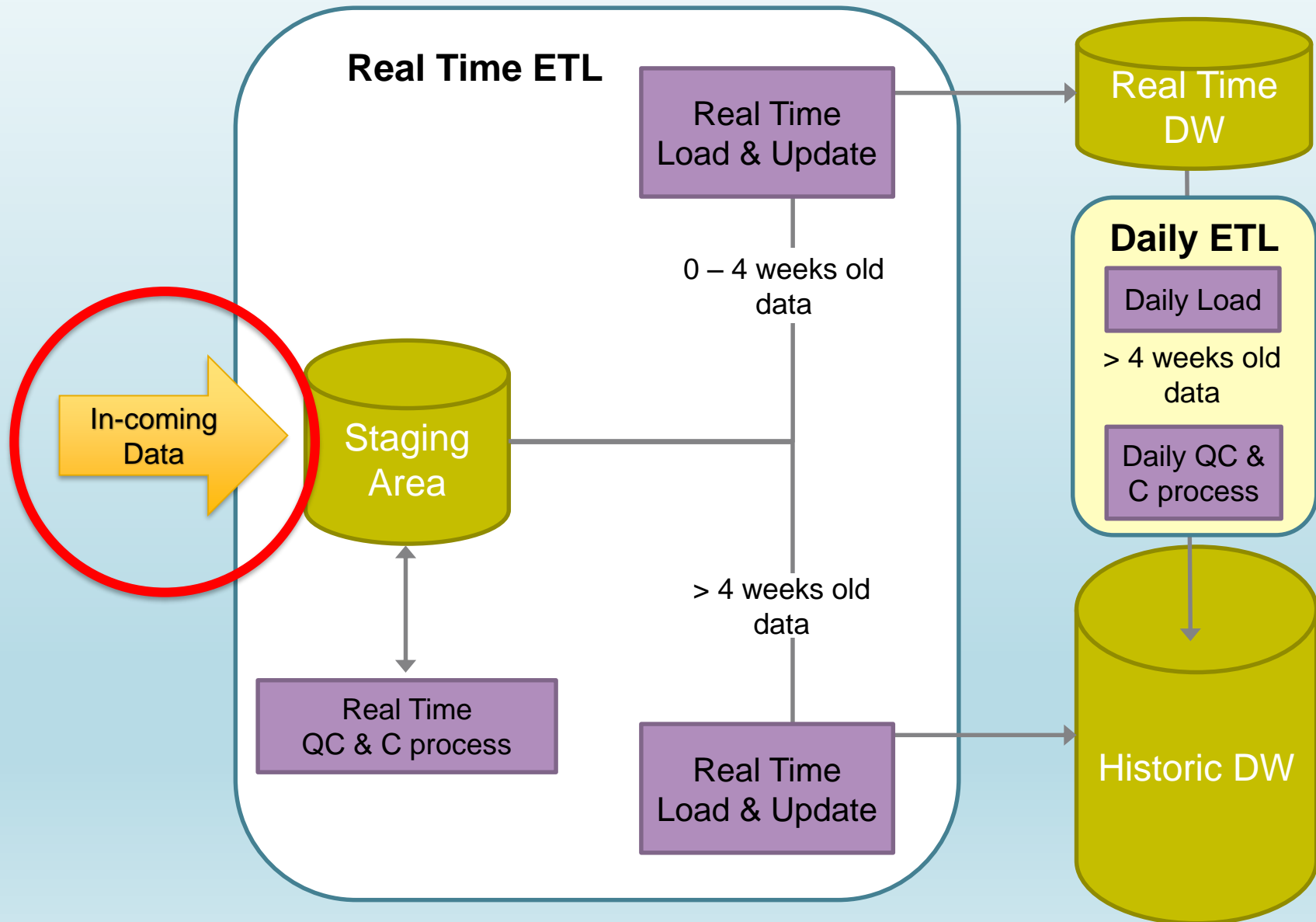


# WRAM: 2 major parts:

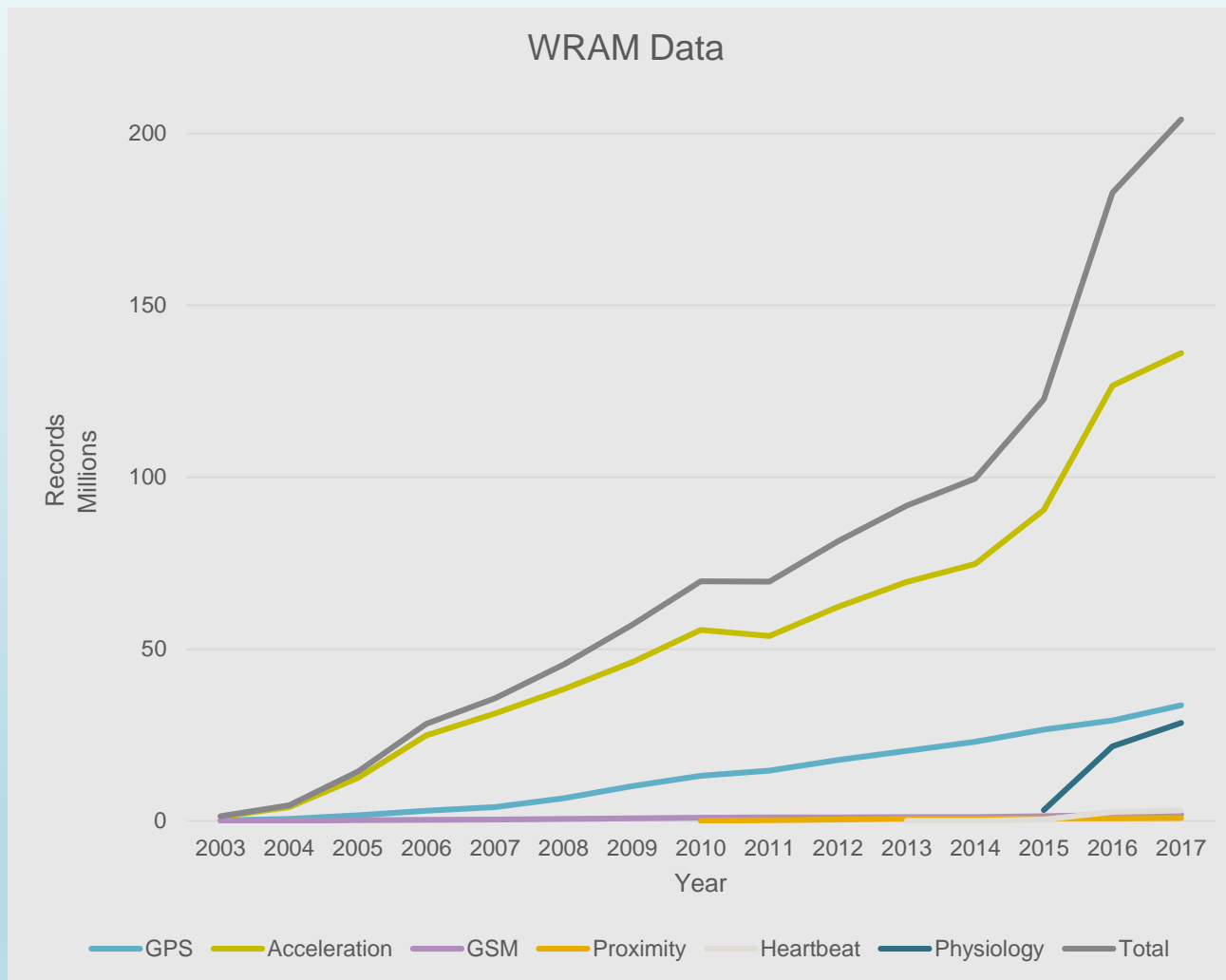
- **WRAM Data Warehouse (WDW)**  
Automatic reception, management & long-time storage of any biotelemetry sensor data from animals
- **WRAM Data Broker (WDB)**  
Federation node for connecting similar data warehouses for biotelemetry sensor-data like WDW, CAnMove, Movebank, EuroDeer



# WRAM Data Warehouse



# WRAM Data Warehouse



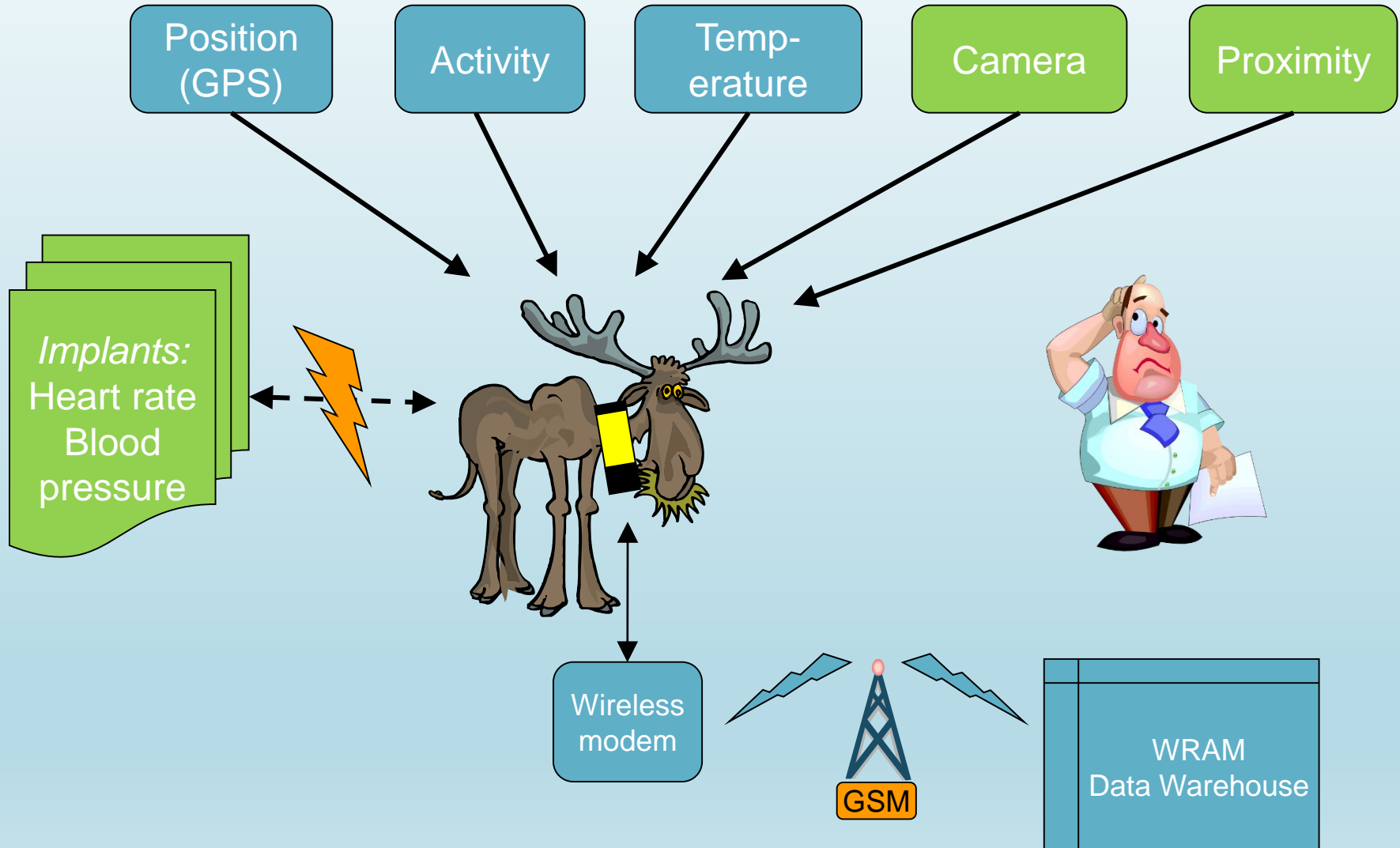
# WRAM Data Warehouse

## Status (April 2018)

- Used in Sweden, Finland, Norway, Denmark, Croatia, Africa
- 37+ projects / user groups
- 24+ species (moose, golden eagle, wolf, deer, reindeer, lion, small birds..)
- 3 747 animals
- 13 tag types, 29 data formats
- Ca. 210.1 M measurements  
(Position, acceleration, proximity, body temperature, heart beat, GSM quality)
- Increasing with ca. 40 M records annually



# New sensors = New tables?





# Serialized table structure

Common solution:

2 sensors = 2 tables,  
different structures

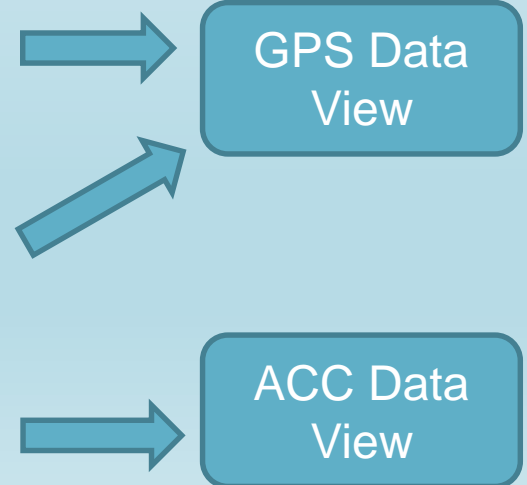
GPS_ID	Collar_ID	GMT_date	Longitude	Latitude	Height	DOP
7	00989	2007-10-16 01:00	13.5255491	52.4307329	102.59	1.8
6	00989	2008-02-12 10:50	20.3138766	63.82058	29.05	3.4

ACC_ID	Collar_ID	GMT_date	X	Y
2	00989	2008-02-11 10:01	15	156
3	00989	2008-02-13 13:10	28	17

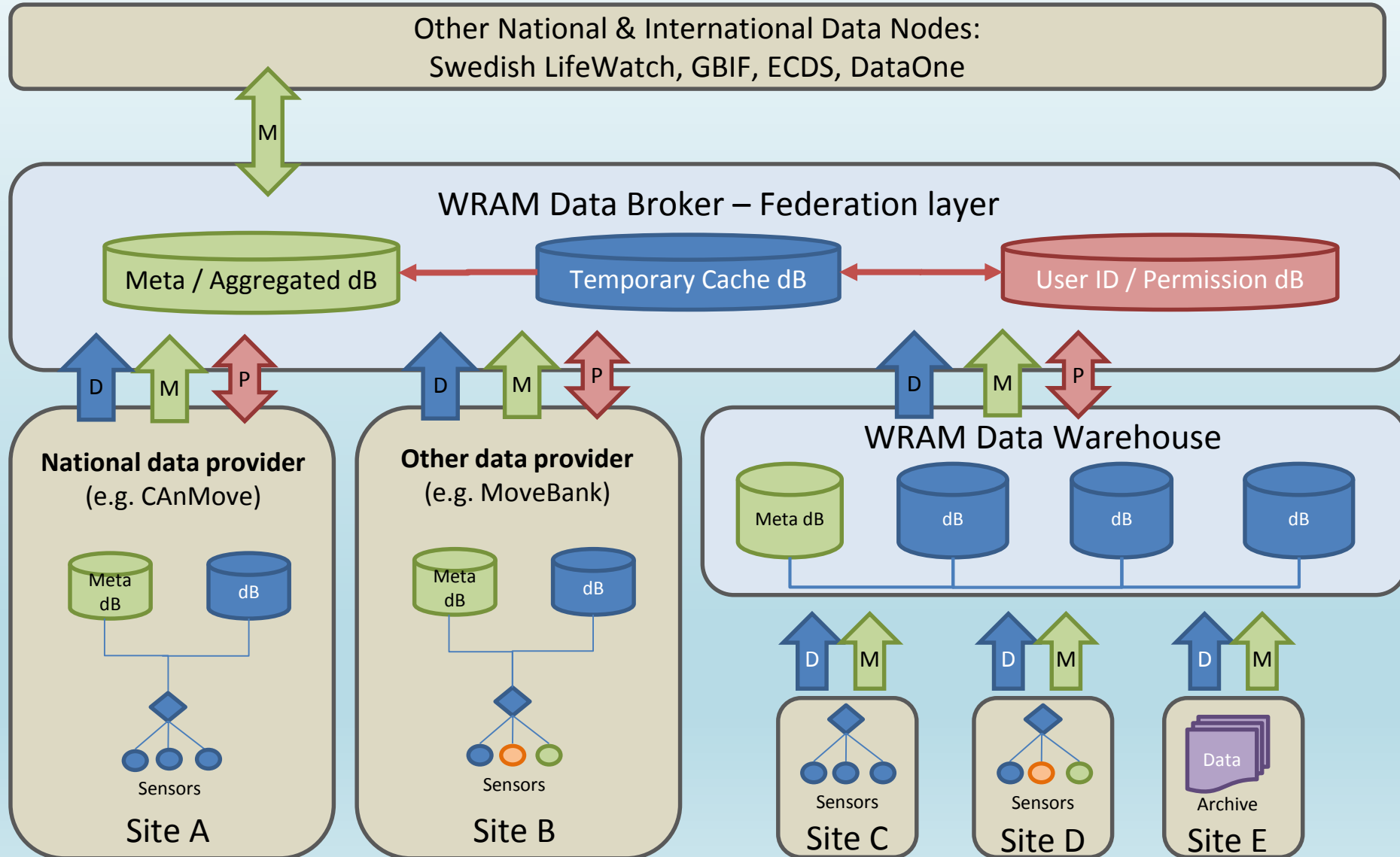
WRAM 2 solution:

2 or more sensors = 1 table,  
generic structure with key-value pairs

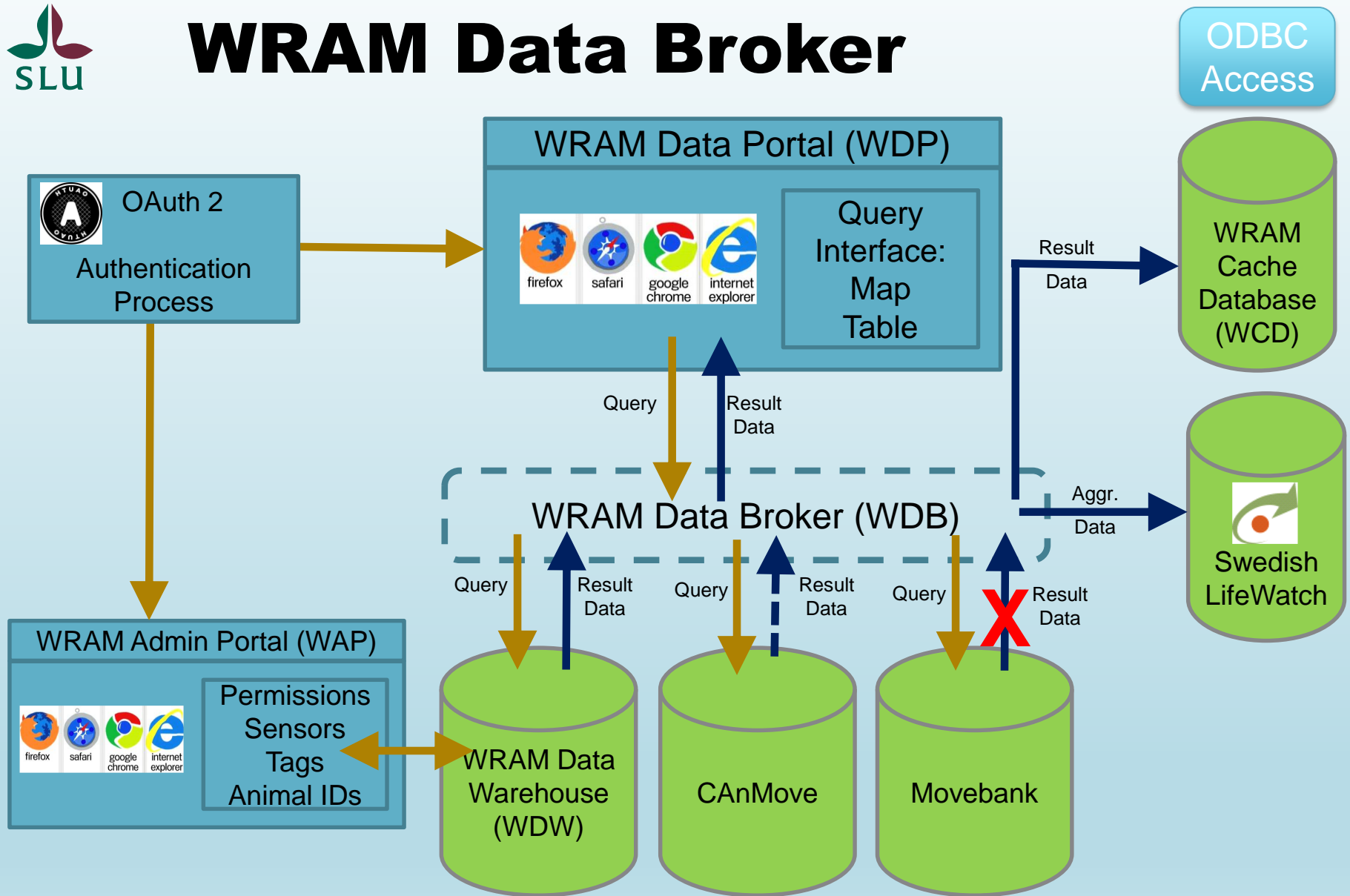
M_ID	Sensor_Type	Sensor_ID	Measure_ID	SensorValue_ID	Value
1	GPS	00969	1	1	2007-10-16 01:00
2	GPS	00969	1	2	13.5255491
3	GPS	00969	1	3	52.4307329
4	GPS	00969	1	4	102.59
5	GPS	00969	1	5	1.8
6	GPS	00969	2	1	2008-02-12 10:50
7	GPS	00969	2	2	20.3138766
8	GPS	00969	2	3	63.82058
9	GPS	00969	2	4	29.05
10	GPS	00969	2	5	3.4
11	ACC	00969	3	1	2008-02-11 10:01
12	ACC	00969	3	2	15
13	ACC	00969	3	3	156



# WRAM Data Broker



# WRAM Data Broker



# WRAM Data Portal

addad - Sök p... Advanced que...

Not secure https://localhost:44301/AdvancedQuery

Moose Movement weekly Description of query

Add a shared query

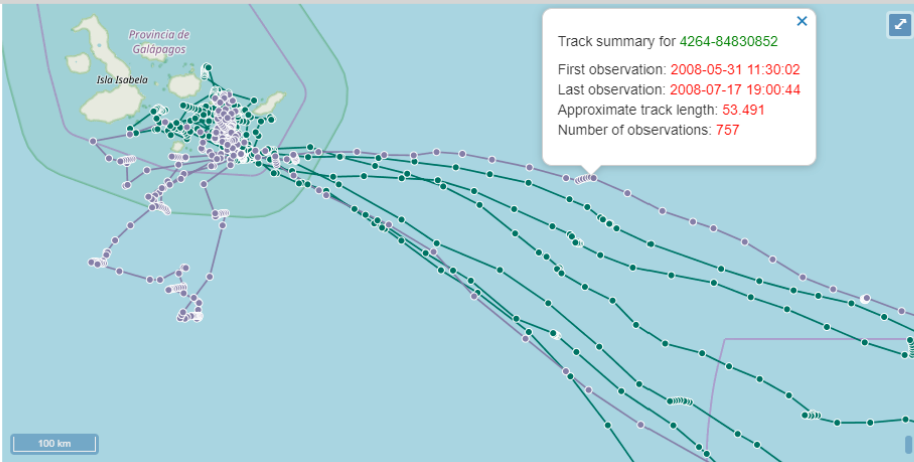
### Public queries

Name of query	Description of query
Moose Movement 3 months	Description of query
RDV Proximity	Description of query
RDV - AggAnimal Track	Description of query
RDV-W1 ACT	Description of query
RDV W2-GSM	Description of query

CacheDB Login Details

Query editor

Results



Track summary for 4264-84830852

First observation: 2008-05-31 11:30:02  
Last observation: 2008-07-17 19:00:44  
Approximate track length: 53.491  
Number of observations: 757

100 km

fid	dataprowider	dataowner	projectid	animalid	animalsid	tagid	sensorid	datasetdoi	species	srid	confidencevalue	observationdate
10289_styled.4264-84830852	Movebank	Martin Wikelski	Galapagos	4264-84830852	131				Phoebastria irrorata	4326	1	2008-jun-04 06:00:55
10289_styled.4264-84830852	Movebank	Martin Wikelski	Galapagos	4264-84830852	131				Phoebastria irrorata	4326	1	2008-jun-04 07:30:46

SELECT ALL  
INVERT

- 1094-1094
- 1103-1103
- 1163-1163
- 2131-2131
- 2368-2368
- 2382-2382
- 3272-3272
- 3275-30662
- 3606-30668
- 3655-27659
- 4261-2228
- 4262-84830876
- 4263-1135473
- 4264-84830852
- 4265-8483009431
- 4266-84831108
- 4267-84830990
- 4268-8582220031
- 4269-4831216
- 4270-84831217
- 4271-84831889
- 4272-84831758
- unbanded-151
- unbanded-153
- unbanded-154
- unbanded-156

# WRAM Data Portal

addad - Sök p... Advanced query

Not secure https://localhost:44301/AdvancedQuery

Name of query Description of query  
 Moose Movement 3 months Description of query  
 RDV Proximity Description of query  
 RDV - AggAnimal Track Description of query  
 RDV-W1 ACT Description of query  
 RDV W2-GSM Description of query

CacheDB Login Details

Query editor

Results

2000 rows of data are available in the Cache Database. 1 - Row 1 to 150

DataProvider	DataOwner	ProjectID	AnimalID	TagID	SensorID	DatasetDOI	Species	SRID	SpatialPoint	ConfidenceValue	ObservationDate
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6210002 -1.3895437)	1	2008-06-23 16
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6210024 -1.3895456)	1	2008-06-23 16
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6209386 -1.3895534)	1	2008-06-23 18
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6209727 -1.38957)	1	2008-06-23 19
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6210144 -1.38957)	1	2008-06-23 21
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6209908 -1.3895207)	1	2008-06-23 22
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6208941 -1.3895708)	1	2008-06-24 00
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6209346 -1.3895928)	1	2008-06-24 01
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6210769 -1.3895771)	1	2008-06-24 03
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6210023 -1.3895477)	1	2008-06-24 04
Movebank	Martin Wikelski	Galapagos Albatrosses	1094-1094	146			Phoebastria irrorata	4326	POINT (-89.6209765 -1.3895571)	1	2008-06-24 06



# WRAM Data Portal

- ODBC link to Cache dB (PostgreSQL or SQL Server)
- Use local analysis tools
- e.g., MS Access or R Statistics



FILE HOME CREATE EXTERNAL DATA DATABASE TOOLS TABLE TOOLS FEEDB: Database- \\storage-ume.slu.se\home\j\jahnd\My Documents\SLU\VR\Data\FEDB.accdb (Access 2007 - 2013 file format) - Access

Import & Link

All Access Objects

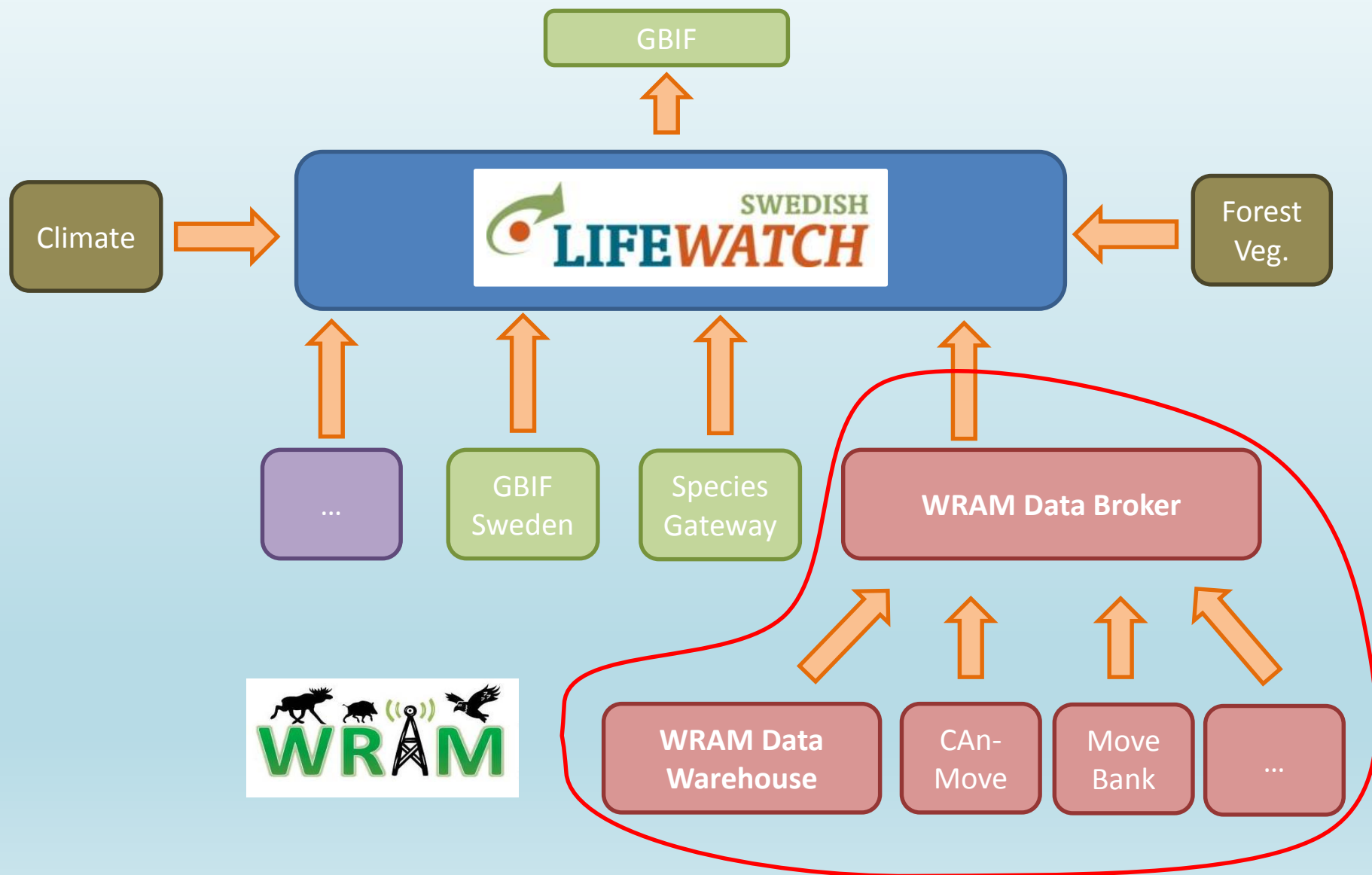
Search...

Tables

dbo\_W2\_AnimalTrack\_fedb\_wdb\_devslu\_ckidn

DataProvider	DataOwner	ProjectID	Data:	Species	AnimalID	TagId	SensorId	ObservationDate	Latitude	Longitude	Height	Depth	SRID	SpatialPoint
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	402	7	629	2003-04-16 09:30:05	64.1340462000	17.4645797000	387.9600000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	406	18	622	2003-04-06 03:30:56	64.1551877000	17.2474095000	353.6400000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	410	6	621	2003-03-05 11:30:42	64.1481488000	17.5277079000	364.9100000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	415	8	637	2003-03-09 10:30:25	64.1669844000	17.0749753000	362.3000000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	423	9	623	2003-03-22 21:30:19	64.1845228000	17.4671900000	364.8100000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	422	4	636	2003-06-07 16:00:48	64.9858271000	16.7021235000	492.3300000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	419	5	627	2003-08-18 04:02:52	64.2951968000	16.9901600000	505.2200000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	412	14	631	2003-06-13 00:30:50	64.7637772000	16.1198381000	379.9600000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	410	6	621	2003-08-30 19:30:16	64.6915222000	17.1071104000	501.9900000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	415	8	637	2003-09-03 11:32:06	64.1129839000	17.1298660000	388.8600000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	416	12	641	2003-07-04 20:01:26	65.0740035000	16.5675818000	513.8900000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	405	26	619	2003-06-11 10:30:34	64.4583959000	17.0926565000	388.1700000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	424	25	626	2003-05-26 23:00:43	65.0837392000	16.2969065000	581.7800000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	414	23	632	2003-08-06 00:00:25	64.2444891000	17.0412391000	438.9700000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	407	10	625	2003-04-09 03:30:42	64.1839691000	17.4739018000	350.2300000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	405	26	619	2003-12-06 11:30:30	64.4556236000	17.0568196000	380.7200000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	422	4	636	2003-04-07 22:00:43	64.1887039000	17.5128686000	421.4800000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	419	5	627	2003-04-30 21:30:42	64.2581900000	17.2758915000	368.3900000000	.000000000000	4326	E6100000010D
WRAM 2	Holger Dettki	GPS_MooseAC03		Älg	412	14	631	2003-04-13 13:00:21	64.1387121000	17.1873888000	419.1700000000	.000000000000	4326	E6100000010D

# LifeWatch - WRAM



# Swedish LifeWatch - WRAM

The Analysis portal for biodiversity data

Log in

SWEDISH LIFEWATCH

Start Data Filter Settings Result Info My Pages

Data > Species observations (databases)

Save settings Download metadata

<input checked="" type="checkbox"/>	Data provider	Number of observations	Number of public observations
<input checked="" type="checkbox"/>	Species Observations System (Artportalen) (Swedish Species Information Centre (ArtDatabanken)) <a href="#">?</a>	62,539,345	62,142,998
<input checked="" type="checkbox"/>	Observation database of Redlisted species (Swedish Species Information Centre (ArtDatabanken)) <a href="#">?</a>	725,929	0
<input checked="" type="checkbox"/>	MVM (Environmental data MVM, SLU) <a href="#">?</a>	1,119,223	1,119,223
<input checked="" type="checkbox"/>	The National Register of Survey test-fishing (NORS) (Department of Aquatic Resources, SLU) <a href="#">?</a>	2,693,173	2,693,173
<input checked="" type="checkbox"/>	The Database for electrofishing in streams (SEBS) (Department of Aquatic Resources, SLU) <a href="#">?</a>	407,425	407,425
<input checked="" type="checkbox"/>	Wireless Remote Animal Monitoring (WRAM) (Umeå Center for Wireless Remote Animal Monitoring (UC-WRAM), SLU) <a href="#">?</a>	7,906	7,906
<input checked="" type="checkbox"/>	Shark SMHI (Skivring) <a href="#">?</a>	609,171	609,171
<input checked="" type="checkbox"/>	The database for coastal fish (KUL) (Department of Aquatic Resources, Institute of Coastal Research, SLU) <a href="#">?</a>	231,079	231,079
<input checked="" type="checkbox"/>	Bird ringing centre in Sweden via GBIF (Swedish Museum of Natural History) <a href="#">?</a>	4,821,039	4,814,212
<input checked="" type="checkbox"/>	Porpoises (NRM) via GBIF (Swedish Museum of Natural History) <a href="#">?</a>	2,191	2,191
<input checked="" type="checkbox"/>	Entomological Collections (NHRS) from GBIF (Swedish Museum of Natural History) <a href="#">?</a>	35,528	35,525
<input checked="" type="checkbox"/>	Swedish Malaise Trap Project (SMTP) from GBIF (Foundation Station Linné) <a href="#">?</a>	95,992	95,992
<input checked="" type="checkbox"/>	Swedish Virtual Herbarium (Umeå University) <a href="#">?</a>	2,290,798	2,283,767
<input checked="" type="checkbox"/>	Tree Gateway (Swedish Species Information Centre (ArtDatabanken)) <a href="#">?</a>	581,362	581,362
<input checked="" type="checkbox"/>	Clam Gateway (Swedish Species Information Centre (ArtDatabanken)) <a href="#">?</a>	13,015	13,015
	Sum	76,173,176	75,037,039

At least one data provider must be selected

My selections

Data

Data Providers (15 selected) [?](#)

Filter

☒ Occurrence [?](#)

Settings

Summary statistics [?](#)

Grid statistics [?](#)

Time series [?](#)

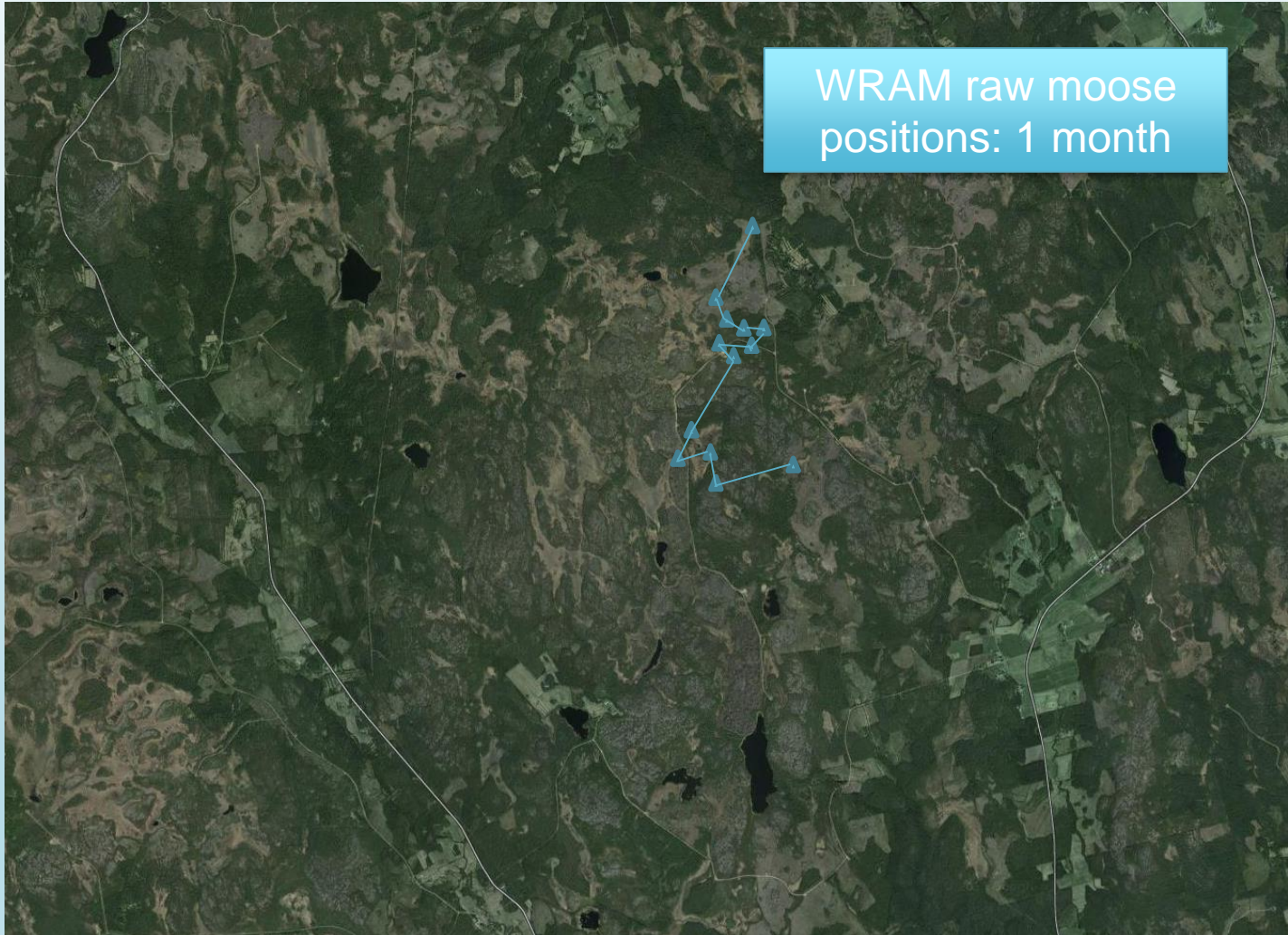
Coordinate system [?](#)

Table columns [?](#)

File format [?](#)

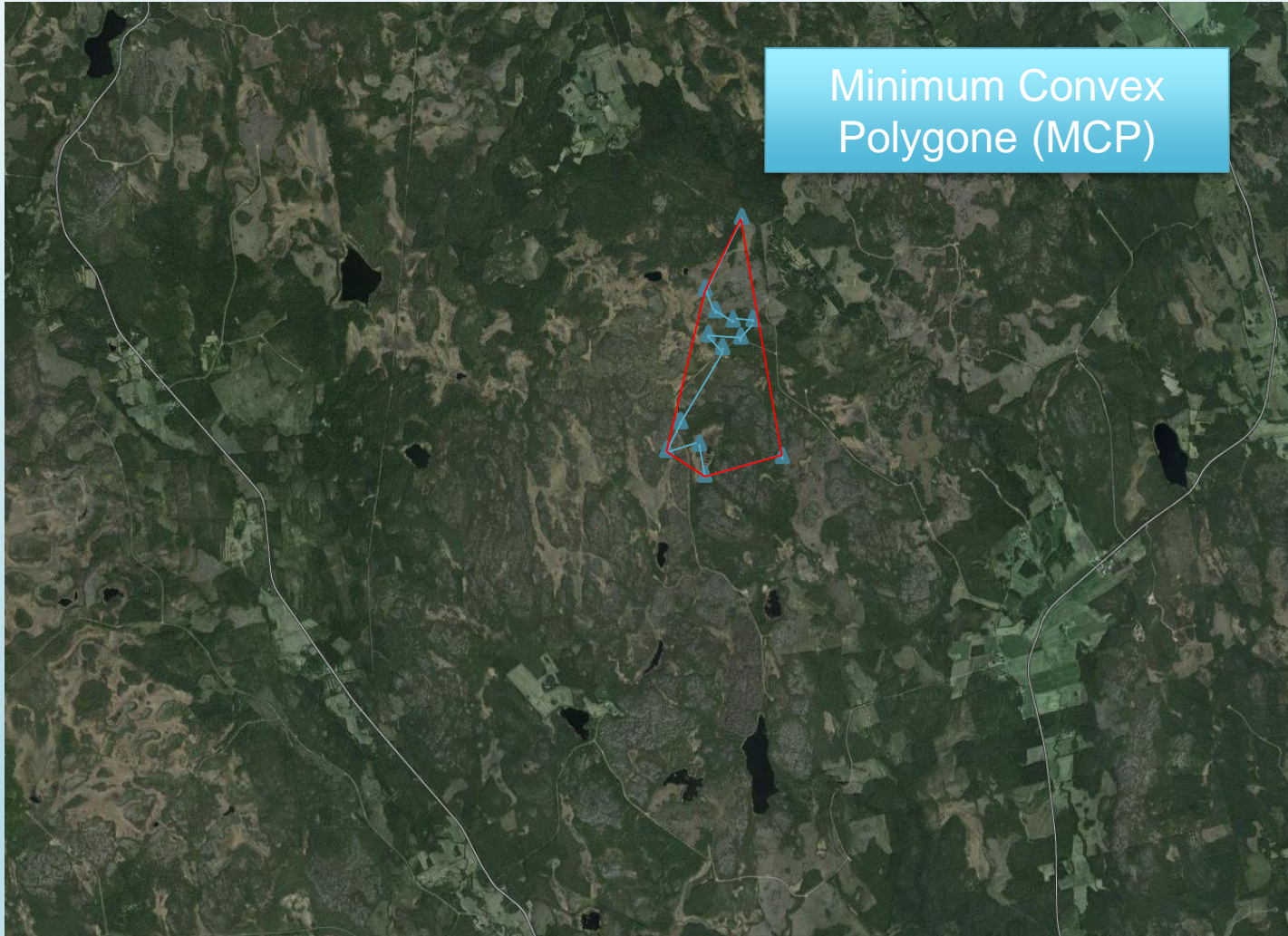
Reset

# Aggregating data



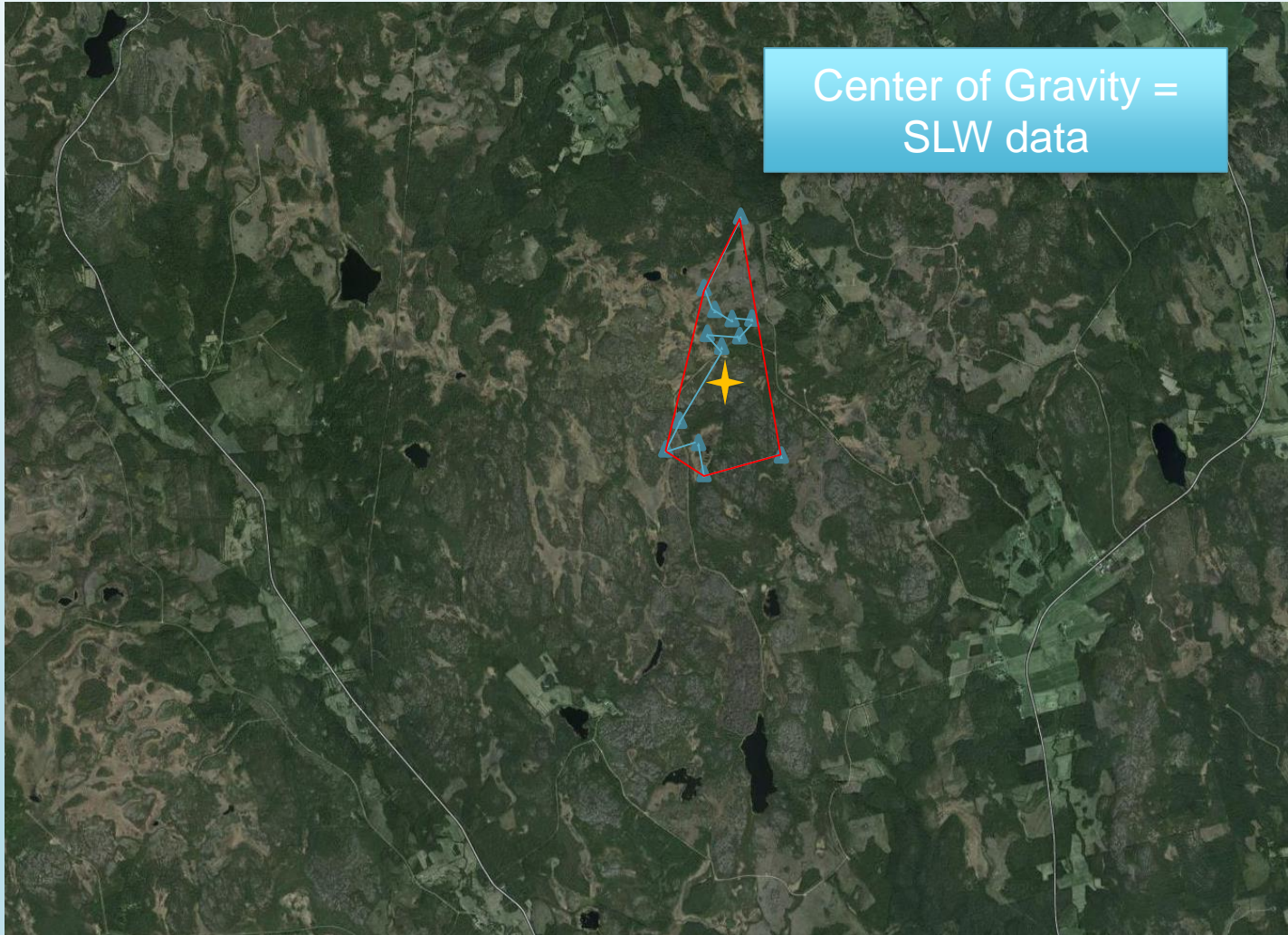


# Aggregating data





# Aggregating data



# Take-home message



- Long-time storage of biotelemetry sensor data – any sensor, any data
- Single portal, single log-on regardless of dB or tag provider
- Full data owner control of access permissions  
Even single positions or data records
- Automatic merging of data from different dBs
- Simple future sharing of data, cooperation made easy





# Thanks!

Thanks to our financers:  
Swedish University of Agricultural Sciences  
Swedish Research Council  
Kempe-Foundation  
Swedish EPA  
Swedish Sami Parliament



Centre for Animal Movement Research  
Lund University, Sweden

EURODEER collaborative project



Environmental Monitoring and  
Assessment



And Thanks to our  
colleagues and partners  
who contributed to this  
research and development!