

Summary of Thematic Workshop

# Animal Movements

*Ecosystems and Societal Impacts*



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October 5–6<sup>th</sup>, 2016  
Swedish University of Agricultural Sciences, Umeå

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## Workshop Summary

The Workshop was a great success. We managed to bring together a bright group of people who actively interacted and raised the profile of the topic tremendously, while also creating a great working group with a broad expertise in a wide array of topics. All the speakers have expressed their excitement for the workshop through encouraging comments.

*“It was really nice to take part of the workshop and to get that broad view on the research needs that are and the works that are done in Sweden today. Well done!”*

*“Thanks for organising this fantastic workshop and for inviting me to come! It was indeed very interesting to hear all the talks and I especially liked learning more about the applied aspects of migration. I think it is really important with interactions between more basic and applied research and there is still so much to do.”*

*“Thanks for a very interesting and well organized workshop.”*

*“Thanks for taking this initiative. A well organized and most rewarding workshop. I sincerely hope that we find ways to continue this networking.”*

## Background

### *Aim*

The aim of the workshop was to bring together an interdisciplinary group of experts to address important ecological and societal issues related to animal movements across terrestrial, freshwater and marine systems.

Sweden is well poised to take a lead in a cross-disciplinary effort in this field, bringing together leading expertise from many disciplines and using this knowledge to tackle problems of global scale, in both the developed and the developing world.

### *Scope*

Animal movements are a feature of all ecosystems. Movements link ecosystems by transporting nutrients, energy, genetic material, reproduction, foraging and being eaten. On the other hand, movements also allow populations to access the best areas round the year and become abundant. Many migrations and movements have been lost and many are under threat of being lost, due to rapidly occurring global changes, both in land and water use and climate. The loss or hindrance of movements has implications; both on species persistence and the ecosystems they link, as well as the human society. A crucial example is the loss of ecosystem services such as pollination, due to extinction and curtailment of insect pollinators attributed to land use change and use of insecticides. Similarly, by movements, numerous animals collide with roads and railways, hydroelectric power plants, fishing vessels, windmills, power lines, and other human made infrastructure. As habitats are modified and humans also move closer to animals, the likelihood of transmission of zoonotic diseases also increases rapidly. This makes movement an important societal issue with many social, human health, political, and economic dimensions. Such issues indeed form societal opinions as well as form attitudes towards nature and developments. However, we still know relatively little about the movements of most species; when the human impacts on movements are high and conservation and management is need of the hour. Moreover, movements such as migrations have affected humans (pastoralists, hunters, trappers and fishermen) for millennia, and these lifestyles are being affected dramatically. This warrants a multidisciplinary approach to tackle issues arising from animal movement.

During the last two decades, our understanding about the causes and consequences of animal movements has begun to increase dramatically through the developments in science, monitoring and improvements in technology for tracking animals as well as remote sensing and genetic sequencing techniques. As a result, we are today in a strong position to study the underlying causes and consequences of animal movements at a resolution never studied before. Moreover, because of these powerful new technologies, movement data is simultaneously in transition towards the '**Big data**' category, meaning data collection and handling occurs in large databases with complex structures such as encountered within 'Google search', 'Amazon Inc.', or 'Facebook Inc.'. This has important implications for future natural resource conservation and management.

### *Thematic Workshop – Animal Movements: Ecosystems and Societal Impacts*

There is potential to create a national and global research programme/platform on animal movement research, where cross-taxonomic comparisons can be made and synergies and common solutions can be found to general societal problems arising from movements. These problems are global. Many of the societal issues related to animal movement are especially urgent in developing countries (few data, vulnerable societies, vulnerable individuals, scarcity of

resources for mitigation/adaption). The thematic workshop provided a great opportunity to bring together the researchers, stakeholders, funders and policy makers to encounter the issue heads on and develop a path for future work and urgent needs on the topic and its global appeal.

## Abstracts

*Navinder J Singh, SLU*

### **Animal movements: Ecosystems and Societal Impacts**

Animal movements are a feature of all ecosystems however the impacts of movements on ecosystems and society are underestimated. The original natural drivers of movements that include predation, climate, food or disease have been greatly affected due to increasing human modifications of land and seascapes. As a result, a new approach is needed that incorporates anthropogenic drivers in combination with natural drivers to understand the causes and consequences of animal movement in today's world and their enormous ecological and economic impacts. The time is ripe to address this issue due to the rapid advancements in tracking methods as well as development of novel analytical and modelling approaches in understanding and predicting movements. This will allow us to reach the national environmental goals as well as global biodiversity targets. However, to achieve this, we will require a joint multidisciplinary effort of researchers, industry, local, national, and global agencies and authorities as well as stakeholders.

*Christer Brönmark, Lund University*

### **The causes and consequences of migration**

Research at the Centre for Animal Movement Research (CAnMove) at Lund University has as a goal to understand the ecological and evolutionary causes and consequences of animal movements across scales. Many of the researchers in CAnMove focus on migration, trying to answer questions such as: Where and When are animals migrating? How do they find their way? What adaptations do they have for efficient movement? Why do they migrate? and What are the consequences for populations and ecosystems? In a project with roach *Rutilus rutilus*, a zooplanktivorous, freshwater fish, we have focused on the Why and Consequences questions and our results show that roach migrate from lakes into wetlands during winter and back again in summer according to a seasonal and habitat specific cost/benefit trade-off, where there is a high cost of predation in the lake year around but only a benefit of high food availability during summer. In the streams the predation pressure is always very low. Further, the migration is partial and this is driven by individual properties that affect the trade-off, such as size, condition and behavioural strategies. We have also modelled the effect of migration on lake ecosystems and the results suggest that the proportion and timing of roach migration may affect the establishment of submerged macrophytes in spring.

*Kjell Leonardsson, SLU*

### **Fish migration in space and time**

In this talk I will highlight our status of knowledge on drivers of fish migration and what are gaps in our understanding of fish movement behaviour and flow preferences so as to guide them through hydropower plants. I will give an example of up and downstream migration of salmon smolts migration in the Umeå river.

*Frauke Ecke, SLU*

### **Linking moving animals and humans with zoonotic diseases**

Emerging infectious diseases are an increasing burden to public health. More than 60 % of all emerging infectious diseases are zoonotic, i.e. spread from animals to humans, and more than 70 % of these originate in wildlife. Broad patterns in outbreaks of emerging infectious diseases have been related to for example migratory birds and moving humans. However, mechanisms behind many zoonotic diseases are found at small spatial scales and involve the contact and contact zone between reservoir hosts (here wildlife species) and humans. Nephropathia epidemica (NE; Swedish: sorkfeber) and Lyme disease (Swedish: borelios) are two zoonotic diseases of high societal relevance in Sweden. Recently, we gained knowledge on biotic and abiotic factors influencing prevalence and human risk of NE caused by the Puumala virus (PUUV) that has bank voles (*Myodes glareolus*) as its only host. Still, for NE we don't know the exact factors triggering bank vole movement into human dwellings. It's this movement that most likely increases transmission risk of PUUV to humans and hence outbreak of NE. Lyme disease as a tick-borne disease most likely also involves several small rodent species, medium-sized mammals, birds and ungulates. The transmission mechanisms of the pathogen (*Borrelia burgdorferi*) causing Lyme disease as affected by animal (especially ticks, small rodents and ungulates) as well as human movement and behavior are largely unknown. To understand and mitigate transmission and outbreak of zoonotic diseases, and hence to lower the burden to the public health sector, it's crucial to understand the linkage between movement and behavior of pathogen hosts and humans.

*Håkan Sand, SLU*

### **Human wildlife conflicts with the return of large carnivores**

During the last decades there has been a strong comeback of large carnivores into formerly predator free areas of Europe. Parallel research efforts have casted new light on the potential importance of top carnivores for terrestrial ecosystems processes, prey density and behavior, and for ecosystem biodiversity. However, the return of large carnivores often result in conflicts with humans in several ways including impact on game populations, depredation on domestic animals, and pure fear among people. A part of this problem is that these animals move over large areas with high mobility and their presence are therefore unpredictable in space and time. These movements can be studied in multiple ways to improve our understanding of the ecology of these animals and this knowledge is often important for their management and conservation including mitigating conflicts with humans. The movement pattern of large carnivores may be instructive for the species ecology and link closely to ecological components such as; genetic structure and exchange with other populations; estimation of population size and design of optimal census routes; estimation of predation impact on prey/game species; and to factors linked to future population development and distribution.

*Fredrik Widemo, Svenska Jägareförbundet and SLU*

### **Hunting management of moving animals**

Viltets rörelser i landskapet påverkar såväl möjligheterna till beskattning, som vilken påverkan viltet har på möjligheterna att bedriva jord- och skogsbruk med acceptabla skador. Vidare kan inriktningen på markanvändningen bidra till att styra viltet, samtidigt som olika typer av landskapselement och infrastruktur kan förhindra viltets rörelser. Kunskap om hur viltet utnyttjar landskapet och viltets rörelsemönster är central för många av besluten inom viltförvaltningen. Det gäller ända från beslut inom jakten på enskilda fastigheter, till förvaltningsbeslut på läns-

eller nationell nivå exempelvis vid sjukdomsutbrott. Förvaltningsnära forskning på det jaktbara villtets rörelsemönster är följaktligen av stort intresse för viltförvaltningen och jägarkåren.

*Henrik Smith, Lund University*

### **Consequences of animal movement for the scale-dependent production of ecosystem services in anthropogenic landscapes.**

Biodiversity and biodiversity-based ecosystem services in agricultural landscapes are threatened by ongoing agricultural change, resulting in increased within-field farming intensity and loss of semi-natural habitats across farms and landscapes. In Europe the conservation of biodiversity and reduction of external inputs by promoting ecosystem services is high on the policy agenda for agriculture, but the success of measures such as agri-environment schemes and the greening of the cap have been small and variable. An important reason for this may be that the landscape-ecology of interventions to promote biodiversity and its services have not been considered. Since organisms in agricultural landscapes inhabit a mosaic of habitats of variable quality and temporal duration, such understanding requires fundamental knowledge on the movement ecology of organisms. In this talk we will give examples of how the consequences of interventions to benefit biodiversity and ecosystem service producing organisms depend on both local and landscape context, modified by functional traits related to organismal mobility. We also show that the decision objective used, e.g. whether to preserve biodiversity or to enhance ecosystem services, may give fundamentally different recommendations. Using a production function approach, we show that models to predict consequences of interventions on biodiversity and ecosystem services are capable of accounting for landscape context. We illustrate the importance of including understanding of the landscape-utilization of organisms founded in evolutionary theory, to achieve reasonable predictions of consequences. Since interventions to benefit biodiversity affect multiple organisms acting at multiple spatial scales, we argue that a framework built on spatially coupled interaction webs of organisms acting at multiple spatial scales is necessary to understand consequences of agricultural change.

*Johan Månsson, SLU*

### **Rörelsemönster hos stora betande fåglar, skador och förebyggande åtgärder – en del av Viltskadecenters verksamhet**

Gäss, svanar och tranor (stora betande fåglar) har ökat i antal de senaste 30-40 åren och flera av arterna fortsätter att öka. Dessa fåglar födosöker på åkrar. I de områden där de samlas i stora antal t.ex. under flytt, ruggning och övervintring kan detta leda till konflikter som kostar samhället stora belopp. För att förebygga skador används en rad olika åtgärder som går ut på att skrämja eller locka fåglarna till platser där de inte gör skada. För att effektivisera de förebyggande åtgärderna behövs kunskap om hur fåglarna; 1) rör sig i landskapet, 2) väljer fält och grödor och 3) påverkas av vidtagna åtgärder. Viltskadecenter är en enhet vid institutionen för ekologi, SLU, och är ett kunskapsnav med syftet att samla befintlig kunskap, ta fram ny kunskap och sprida kunskap till förvaltningen genom täta avnämarmarkontakter. I detta arbete har vi de senaste åren framförallt studerat tranor men även sångsvanar och grågäss. I vårt primära studieområde Kvismaren, en viktig höstrastlokal utanför Örebro, har vi kunnat verifiera att tranan är en "central place forager", dvs. de återkommer dagligen till en central punkt (övernattningsplats) som de lämnar på morgonen för att söka föda. Det är högre sannolikhet att de flyger korta än långa sträckor när de födosöker. I alla rastområden längs med flyttvägen genom Europa håller sig tranorna generellt inom 6 km från övernattningsplatsen när de födosöker. De är effektivare på att hitta platser med mycket mat i närheten av övernattningsplatserna jämfört med långt ifrån. Tranornas dagliga aktivitetsområde (Kernel, 90% isopleth) är 4.4 km<sup>2</sup> (2.8-6.0 CRI) och säsonsområde 15.6 km<sup>2</sup> (9.2-22.0), de är relativt



ortstrojna och nyttjar en relativt liten del av hela det tillgängliga rastområdet. Deras rörelsemönster och födosök skapar problem då de ofta övernattar i skyddade våtmarksområden och sedan födosöker på odlade åkrar runt våtmarken eftersom reservaten inte erbjuder tillräckligt med mat. De förebyggande åtgärderna som idag vidtas behöver i framtiden anpassas bättre till den skala som tranorna rör sig på, vilket kommer kräva mer koordinering över större områden.

*Patrik Lantto, Umeå University*

### **Mobility of semi domestic reindeer – a social ecological perspective**

No Abstract available

*Erik Sparrevik, Vattenfall*

### **Fish migration and hydropower**

Many hydropower stations and dams in Sweden are obstacles for fish migration. It is therefore a great challenge to prioritise locations for fish passage solutions. However, the big question is, should we establish fish passages for all species or a target species? Fish passage constructions for downstream migration are usually more complicated than upstream migration. Moreover, challenges concerning fish passage solutions for large-scale hydro compared to small-scale hydro are more difficult. Scientific research based solutions should be used to find measures that are optimal for both hydropower operation and fish migration. Population models are tools that can be useful to find how fish passages could have positive effects on fish populations. Testing of fish passage solutions before construction is important and models and experimental flume facilities can be used.

*Gustav Hellström, Umeå University/SLU*

### **Visualizing animal movements: understanding biology from dots, tracks, colours and animations.**

In this lecture, I will demonstrate the rapidly developing tools and their immense potentials to unravel new insights into animal biology through visualization of animal movement data. I will present many examples from both terrestrial and aquatic ecosystems and show how these visualisations reveal intricate details of animals movement behaviour and its consequences on the management and conservation of biodiversity.

*Lisa Sjölund, SWECO and Trafikverket*

### **Wildlife and traffic: managing collisions**

Trenden för viltolyckorna är stadigt ökande, i vart fall sedan 1970-talet när statistik finns tillgänglig. För alla klövdjursarter (älg, kronhjort, dovhjort, rådjur, ren, mufflonfår och vildsvin) som ingår i statistiken är bilden likartad även om den kan uppvisa mer eller mindre stora variationer i ökningen. Från 2005 och framåt ökar viltolyckorna för älg- och rådjur som dominerar antalet viltolyckor, trots att populationerna minskat. Det sker minst 170 viltolyckor med klövdjur varje dag på Sveriges vägar och järnvägar (över 60 000 per år). Samhällskostnaden för viltolyckor uppgår till över 3 miljarder för viltolyckor på väg och ca 1,5 miljarder för viltolyckor järnväg. Cirka 2/3 av kostnaden för vägolyckor är personskadekostnader och 1/3 egendomsskador. Jaktvärden och eftersök med mera utgör en försumbar andel av kostnaden. För järnvägsolyckorna domineras kostnaden helt av restidsförluster på grund av de stillestånd och förseningar som uppstår i samband med viltpåkörningar. Tillsammans med reparationskostnader

utgör de nästan hela kostnaden. Trafikverket har bedrivit flera projekt inom två forskningsprogram CEDR Research Program - Roads and Wildlife och TIEKOL. Minst 70 % av viltolyckorna är slumpvis lokaliserade. Enbart ca 30 % av klövdjursolyckorna kan knytas till olyckskluster med viss varaktighet (5-10 år) och långt färre, ca 10 %, till kluster med varaktighet som sträcker sig över decennier. Infrastrukturens livslängd sträcker sig snarare över sekler än decennier vilket innebär att anpassningsåtgärder behöver vara generella snarare än specifika. Med utgångspunkt från dessa slutsatser har Trafikverket i Riktlinje landskap (TDOK 2015:0323) formulerat övergripande krav för infrastrukturens utformning bl. a för att minska olyckor.

## Group discussion

In the group discussion part of the workshop, the delegates were split into five groups and were asked to identify “What are the exciting and important research themes, which span across different ecosystems and scientific disciplines, addressing animal movements”.



The delegates showed great enthusiasm and their suggestions were summarized into a ‘synthesis triangle’, suggested by one of the guest speakers, Prof. Henrik Smith of Lund University. The three vertices of the triangle represent the dimensions of improving the **process understanding**, **developing tools** and our knowledge on **conservation and management** of animal movements.

## Programme

### Animal Movements: Ecosystems and Societal Impacts

(Meeting was in both Swedish and English)

**Workshop Venue: P.O. Bäckström Hall and Aspen, 5<sup>th</sup> Floor, SLU**

#### **Day 1 (5th October 2016)**

12:00 – 13:00 Lunch

#### Introduction Session

13:00 Welcome Address: Magnus Tannerfeldt (SSEESS)

13:10 Practicalities: Anders Esselin (SLU)

#### Scientific Agenda – Presentations

13:20 Animal movements – a fundamental function of all ecosystems and society – Navinder Singh (SLU)

13:50 Ecology of Animal Migration – Christer Brönmark (Lund Univ.)

14:10 Migration behaviour in fish in space and time – Kjell Leonardsson (SLU)

#### 14:30 Tea/Coffee Break

15:00 Linking moving animals and humans with zoonotic diseases – Frauke Ecke (SLU)

15:20 Human wildlife conflicts with the return of carnivores – Håkan Sand (SLU)

15:40 Hunting management of moving animals – Fredrik Widemo (SLU, Jägareförbundet)

#### 16:00 Leg stretcher

16:10 Consequences of animal movement for the scale-dependent production of ecosystem services in anthropogenic landscapes – Henrik Smith (Lund Univ)

16:30 Animal movements and wildlife damage center – Johan Månsson (SLU)

16:50 Mobility of semi domestic reindeer – a social ecological perspective – Patrik Lantto (UmU).

#### Social Activities

17:10 Bar (paid in cash by delegates)

19:00 Dinner at Gotthards Krog, Umeå city.

#### **Day 2 (6th October 2016)**

#### Societal Challenges

08:30 Fish migration and hydro power – Kjell Leonardsson (SLU and Vattenfall)

08:50 Visualizing animal movements – Gustav Hellström (UmU)

09:10 Wildlife and Traffic: managing collisions - Lisa Sjölund (SWECO)

#### 09:30 Tea/Coffee Break

10:00 WS: What are the exciting and important research themes, which span across different ecosystems and scientific disciplines, addressing animal movements?

11:15 Financing of research and national infrastructure - Johanna Spångberg (Vetenskapsrådet)

11:30 Future Earth perspective – Magnus Tannerfeldt (SSEESS)

11:45 Summary of meeting

12:00 End of meeting and lunch

## List of Delegates

<b>Name</b>	<b>Organization</b>
Adriaan De jong	SLU Umeå
Anders Esselin	SLU Umeå/Man & Nature
Anders Telenius	GBIF, NRM
Andrew Allen	SLU Umeå
Christer Brönmark	Lund Univ.
Christoffer Ekström	Stockholm Univ.
Eirini-Lamprini Douti	SLU Umeå
Erik Sparrevik	Vattenfall AB
Eva Lindberg	SLU Umeå
Frauke Ecke	SLU Umeå
Fredrik Widemo	Jägareförbundet, SLU
Gladys Mosomtai	Umeå Univ
Göran Ericsson	SLU, Umeå
Gustav Hellström	Umeå Univ
Håkan Sand	SLU, Grimsö
Hans Lundqvist	SLU Umeå
Henrik Smith	Lund Univ.
Holger Dettki	SLU Umeå
J-O Helldin	CALUNA
Jens Persson	SLU Grimsö
Johan Månsson	SLU Grimsö
Johanna Spångberg	Vetenskapsrådet
Kim von Hackwitz	SSEESS
Kjell Danell	SLU Umeå
Kjell Leonardsson	SLU Umeå
Lisa Sjölund	SWECO
Magnus Tannerfeldt	SSEESS
Matthew Knibb	SLU Umeå
Michael Schneider	AC Län
Navinder Singh	SLU Umeå
Ornella Jogi	Lund Univ.
Patrik Lantto	Umeå Univ.
Per Sandström	SLU Umeå
Thomas Palo	SLU Umeå