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# 8th International Martes Symposium Book of Abstracts

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X @martesgroup #Martes2023



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# Welcome

We are delighted to welcome you all to the 8th International Martes Symposium in Aviemore, Scotland.

Over the four days of the symposium, we're looking forward to some great oral presentations and posters, along with lots of opportunities for networking and exchanging ideas. We're also pleased to welcome our three keynote speakers who, between them, will be covering a variety of topics on Martes ecology, evolution and conservation from different geographical and research perspectives.

We are also grateful to the organising and scientific committees, who contributed to planning the symposium and reviewed the submitted abstracts. The Book of Abstracts was designed by Julia Bracewell (Vincent Wildlife Trust).

We look forward to meeting you all over the coming days and hope you have an enjoyable, productive and inspiring time at the symposium.

The Martes Working Group Symposium Organising Committee

We are extremely grateful to our sponsors for their generous contributions to this event.

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## Organising committee

- **Rich Weir (Chair)** Artemis Wildlife Consultants
- **Scott Yaeger (Vice Chair)** Ministry of Water, Land and Resource Stewardship
- **Johnny Birks** Swift Ecology (retired)
- **Jenny MacPherson** Vincent Wildlife Trust
- **Steve Carter** Vincent Wildlife Trust
- **Lizzie Croose** (former) Vincent Wildlife Trust
- **Katherine Morley** Vincent Wildlife Trust
- **Pauline Suffice** Université Laval
- **Alice Bacon** Royal Zoological Society of Scotland
- **Kenny Kortland** Forestry and Land Scotland

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- **Sean Matthews** Oregon State University
- **Tim Hofmeester** Swedish University of Agricultural Sciences
- **Izabela Wierbowska** Jagiellonian University
- **Joshua Twining** Cornell University

# Keynote speaker biographies



## **Dr Johnny Birks**

After a PhD and post-Doc research on feral mink in Britain and a bleak survey of England's nearly extinct otters, Johnny worked for the Nature Conservancy Council/English Nature. Always a passionate carnivore defender, in 1993 he joined Vincent Wildlife Trust to study the polecat's recovery, but also began his involvement with research, monitoring and conservation work on pine martens – always on a very part-time basis. In 2007 he co-founded the ecological consultancy Swift Ecology and was Chair of the UK's Mammal Society (2009-2015). He is now supposed to be retired, but finds martens so utterly charming, and their recovery in Britain so uplifting, that he cannot resist the temptation to start his next 30 years of marten work.



## **Dr Jenny Mattisson, Norwegian Institute for Nature Research, Trondheim, Norway.**

Dr Jenny Mattisson is a researcher at the Norwegian Institute for Nature research (NINA) in Trondheim, Norway. She is a wildlife ecologist with a background in predator-prey interaction, wildlife-human conflicts and spatial ecology. Before joining NINA in 2011, Jenny gained her PhD from the University of Agricultural Sciences, Sweden, where she focused on the interaction between wolverines and Eurasian lynx and their impact on reindeer husbandry. Dr Mattisson's research is partly focused on questions and needs related to carnivore management, including predation on livestock or game species, demography and spatial requirements. She is also involved in the Norwegian Large Predator Monitoring Program (Rovdata), specifically focusing on analysing and report monitoring and genetic data of wolverines and golden eagles.

# Keynote speaker biographies



**Dr Angela K Fuller, US Geological Survey New York Cooperative Fish and Wildlife Research Unit and Department of Natural Resources and the Environment at Cornell University**

Angela Fuller is the Leader of the US Geological Survey New York Cooperative Fish and Wildlife Research Unit and a Professor in the Department of Natural Resources and the Environment at Cornell University. She engages state, provincial, federal, NGO, and international government partners in research to inform conservation and management. Her research focuses on spatial ecology and decision science, integrating ecology, social science, conservation biology, and quantitative modeling to influence the way species and landscapes are managed. In addition, she helps develop and applies new statistical models focused on abundance and occurrence. While her research encompasses a diverse array of mammal species, she holds a special affinity for Martes. Her research spans diverse regions from the United States, Canada, Nepal, Ecuador, Peru, Colombia, Indonesia, and South Africa. She teaches a graduate-level course in decision science at Cornell University. Dr Fuller is a fellow of the Wildlife Society and serves in several science advisory roles including the International Union for Conservation of Nature (IUCN) Species Survival Commission and Bear Specialist Group. She received her PhD degree in Wildlife Ecology from the University of Maine.

# Keynote speaker abstracts

## Dr Johnny Birks

**Out of the frying pan, into the fire?** The story of pine marten survival in Britain against the odds

No other state, probably, has imposed such severe and sustained anthropogenic pressures upon its carnivores as Great Britain. Through the combined effects of early habitat destruction and persecution, apex carnivores were driven to extinction and mesopredators, including the pine marten, suffered drastic population reductions and/or range contractions. Our current efforts to restore native carnivores are hindered by the legacies – ecological, genetic, cultural and socio-economic – of those historic clearances. We are making progress but, despite a pioneering role in the development of global biodiversity conservation, Britain remains one of the most nature-depleted countries in the world.

Via an exploration of the pine marten's turbulent history in Britain and the human forces that shaped it, this presentation celebrates the extraordinary resilience of a woodland mammal that endured the loss of 95% of its preferred habitat. Surviving for decades in treeless, mountainous refugia, a slow, late-twentieth century recovery in the Scottish Highlands was eventually prompted by reforestation and legal protection. This recovery has reached a stage that now allows some cautious translocations to reinforce or re-establish marten populations in England and Wales, though range expansion is bound to be constrained by low woodland cover and poor connectivity.

This presentation also celebrates advances in marten-related conservation science: from scat-based dietary studies starting in the 1950s; through improvements in the rigour of detection surveys and non-invasive monitoring; the development of den boxes to mitigate for the scarcity of tree cavities in modern woodlands; and studies revealing the pine marten's role in ecosystem regulation as it eases its way back into the woodland carnivore guild.

Restoring suitably extensive woodland is but one of the challenges now facing marten conservationists in Britain; others are low genetic diversity, negative attitudes to predators and – the defining challenge of our times – the impacts of global heating and climate breakdown. Globally, the increasing frequency and intensity of wildfires contributes to ongoing primary forest loss, which threatens many species in the *Martes* Complex.



# Keynote speaker abstracts

## Dr Jenny Mattisson

### **Attitude is everything!** The ecology and management of Scandinavian wolverines

The wolverine (*Gulo gulo*) is the largest mustelid species. Its circumpolar distribution spans boreal forest and alpine tundra habitats. The wolverine has a set of physiological and morphological adaptations to these northern environments. However, the defining adaptation of wolverines appears to be its tenacious attitude! This attitude is reflected in its ability to kill prey several times its own body size, and in their large home range sizes and seemingly constant movement. These behavioural adaptations allow them to exploit a wide range of prey (from reindeer to rodents) as well as scavenging opportunities and caching behaviour. Unfortunately, it is also this attitude that brings wolverines into conflict with humans when they kill domestic sheep and semi-domestic reindeer. Most of Norway's land area is subject to free-ranging sheep and semi-domestic reindeer herding, so that wolverine conservation has to occur in areas where conflict potential is high. Wolverines are implicated in around one third of all estimated large predator livestock depredation cases in Norway. In response to these conflicts, the Norwegian government has imposed clear limits on both the size of the wolverine population and its distribution. These limits are enforced by both recreational hunting and lethal control operations conducted by government rangers. The result is that wolverines are likely to retain their status as endangered on the national red list. The positive side-effect of the high conflict levels has been a massive and long-term investment in research and an extensive nationwide monitoring of the wolverine population, using eg, individual-based VHF /GPS telemetry and large-scale collection of scats for non-invasive genetical population monitoring. This has resulted in unique data sets on topics as diverse as space-use, dispersal, denning behaviour, kill rates on various large prey items, caching behaviour, demographics, and gene flow. The data has helped reduce conflicts around the wolverine, for example surrounding appropriate compensation rates and the size of the population, but the underlying conflict with livestock depredation shows little sign of abating, partly because of a lack of will to adopt the difficult changes to sheep husbandry that would be needed to prevent sheep losses.

## Dr Angela K Fuller

### **Exploring the lesser-charted territories: conservation challenges and evidence-based strategies for Martes in a changing world**

As the global landscape continues to evolve at an unprecedented pace, the conservation and management of species in the Martes Complex face increasingly complex challenges. This talk delves into the lesser-explored realms, focusing on the yellow-throated marten and tayra – two of the most widely distributed Martes species, yet both subjects of limited investigation. Leveraging by-catch data sourced from camera trapping studies of large charismatic carnivores, including tigers, leopards, and Andean bears in Nepal and Ecuador, we investigate spatial patterns of occupancy and abundance of lesser-studied yellow-throated marten and tayra. By emphasising the pivotal role of evidence-based decision-making, I advocate for a pragmatic framework that joins rigorous scientific inquiry with an actionable approach to conservation and management. Through the lens of a social-ecological case study involving fishers in New York, I highlight the decision-making process we are using that will lead to a strategy that balances conservation imperatives and trapper desires. I close with discussing the significance of monitoring programs to inform management strategies tailored to the unique characteristics of Martes species.

# Symposium programme

## Day 1 — Monday 11 September

16:00-19:00	Registration desk open	
19:00	'No-host' social at Coylumbridge Hotel, Aviemore	

## Day 2 — Tuesday 12 September

7:30	Registration desk open	
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### Session 1 Chair: Rich Weir

09:00-09:20	Welcome and housekeeping	
09:20-09:40	Using diversionary feeding to reduce nest predation and relieve conservation conflict <i>Jack Bamber</i>	
09:40-10:00	How to avoid the camera TRAP: recommendations for effective use of remotely triggered cameras <i>Katie Moriarty</i>	
10:00-10:30	<b>COFFEE BREAK</b>	
10:30-11:30	<b>Keynote Lecture 1 Dr Johnny Birks</b> Out of the frying pan, into the fire? The story of pine marten survival in Britain against the odds	
11:30-11:50	Wolverine ecology at the southern edge; influence of snow cover, temperature and human activity <i>Malin Aronsson and Jens Persson</i>	
11:50-12:10	Factors influencing winter rest site selection and energetics of American martens <i>Michael Joyce</i>	
12:10-12:30	A unique population of fishers ( <i>Pekania pennanti</i> ) threatened by rapid habitat change <i>Wayne Spencer</i>	
12:30-13:40	<b>LUNCH</b>	

### Session 2 Chair: Scott Yaeger

13:40-14:00	Beyond brotherhood: non-kin alliance among male yellow-throated martens ( <i>Martes flavigula</i> ) in Taiwan <i>Chia-Heng Chung</i>	
14:00-14:20	Space use and abundance of Humboldt marten and their competitors in Northern California <i>Erika Anderson</i>	
14:20-14:40	European pine marten occurrence on Elba island: effects of humans and domestic cats <i>Emiliano Manzo</i>	
14:40-15:00	No room for fishers: decline in the ability of landscape of British Columbia to support female fishers <i>Richard Weir</i>	
15:00-15:30	<b>COFFEE BREAK</b>	

### Session 3 Chair: Sean Matthews

15:30-16:10	<b>RAPID FIRE TALKS</b> <ul style="list-style-type: none"> <li>Thinking outside of the box: reducing bycatch of the endangered fisher in marten box traps <i>Karina Lamy</i></li> <li>Gaining traction on conservation action: modifying human behaviour for fisher habitat conservation <i>Sandra Frey</i></li> <li>Coexistence and competition in sympatric martens within the western Italian Alps <i>Marco Granata</i></li> <li>Re-examining coarse filter management approaches: opportunities and costs for recovering British Columbia's endangered fishers <i>Scott Yaeger et al</i></li> <li>Scaling up from site to region: predicting fisher responses to landscape change <i>Joanna Burgar</i></li> <li>Site occupancy by American martens and fishers in temperate deciduous forests of Québec <i>Pauline Suffice</i></li> </ul>	
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# Symposium programme

16:10-16:30	From metabarcoding to ecology: adaptive prey switching as a means of coexistence between red foxes and pine martens in Scotland <i>Cristian Wagnershauser</i>
16:30-16:50	Red fox and marten, friends or foes? Overlap of diet and spatial and temporal distribution of mesocarnivores in Gorce National Park, Poland <i>M. Strączyński</i>
16:50-17:00	Introduction to The Stacks publishing model <i>David Green</i>
17:00-19:00	Poster Session and Social
<b>Day 3 — Wednesday 13 September</b>	
09:00-17:00	<b>Field Trip am (Max 48)</b> Learn about the <b>Cairngorms Connect</b> initiative with talks from project manager and site managers on habitat restoration. The Cairngorms Connect Predator Project includes research into mesopredators, including martens, and has a lot of data on marten diet and behaviour. The field trip includes site visits to marten habitat, including plantations and Caledonian pinewoods, and talks from biologists, forest managers, conservationists and gamekeepers on opinion on the role of martens in the system and the impact of martens on priority prey species and applied management techniques, etc.
13:00-17:00	Workshop Occupancy Modelling <i>Chris Sutherland</i>
19:00-22:00	Ceilidh in the Cairngorm Suite
<b>Day 4 — Thursday 14 September</b>	
<b>Session 4 Chair: Tim Hofmeester</b>	
09:20-09:40	Space use and habitat selection by fisher ( <i>Pekania pennanti</i> ) in temperate deciduous forest of Quebec <i>Nathan Chabaud</i>
09:40-10:00	The use of tree stratum by tayras ( <i>Eira Barbara</i> ) in areas dominated by domestic dogs ( <i>Canis familiaris</i> ) <i>Isabele Manzo</i>
10:00-11:00	<b>Keynote Lecture 2 Dr Jenny Mattisson</b> <b>Attitude is everything!</b> The ecology and management of Scandinavian wolverines
11:00-11:30	<b>COFFEE BREAK</b>
11:30-11:50	An expert survey to inform regional and global threat assessments and conservation planning for wolverine ( <i>Gulo gulo</i> ) <i>Thomas Jung</i>
11:50-12:20	Rewilding apex predators can structure ecosystems through trophic cascades: ecological consequences of losing stone martens in a Mediterranean forest <i>Tamara Burgos</i>
12:20-13:50	<b>LUNCH</b>

# Symposium programme

<b>Session 5 Chair: Steve Carter</b>	
13:50-14:10	Evaluating population genetic structure of the North American wolverine using microsatellite loci and single nucleotide polymorphisms <i>Elise Stacy et al</i>
14:10-14:50	<b>RAPID FIRE TALKS</b> <ul style="list-style-type: none"> <li>• Use of footprint identification technique (fit) to develop a novel tool for species and sex discrimination of fisher tracks <i>Jody Tucker (RECORDED)</i></li> <li>• Early winter activity: some days in the life of a fisher (<i>Pekania pennanti</i>) <i>Marianne Cheveau and P. Suffice</i></li> <li>• Modeling habitat suitability and connectivity for the endangered yellow-throated marten in South Korea <i>Donggul Woo</i></li> <li>• Resolution revolution: how high-resolution spatial data help detect winter edge effect for American marten <i>Yann Baril-Chauvette</i></li> <li>• Using limiting factors to guide landscape-scale management and recovery of Martes: examples from two subspecies of the Pacific Marten <i>Keith Slauson</i></li> <li>• Behaviour of wild-caught fishers (<i>Pekania pennanti</i>) in captivity prior to translocation <i>J.L. Postigo and Danica Stark (tbc)</i></li> </ul>
14:50-15:30	<b>COFFEE BREAK</b>
<b>Session 6 Chair: Lizzie Croose</b>	
15:30-15:50	A hierarchical modelling approach to predict the distribution, density, and habitat relationships of fishers in Washington, Oregon, and California <i>Sean Matthews</i>
15:50-16:10	Transforming tech: biological insights from elusive forest mustelids from fine-scale GPS data <i>Katie Moriarity</i>
16:10-16:30	Protocol for coupling automated scent dispensers with camera traps to conduct year-long, overwinter surveys of mustelids and other carnivores <i>Robert Long</i>
16:30-16:50	Sociality in unexpected places: Using global camera trapping data to test the drivers of social complexity in the Martes complex <i>Joshua Twining</i>
16:50-18:00	Martes Working Group Business Meeting
19:00	Conference Dinner, Auction and Raffle
<b>Day 5 — Friday 15 September</b>	
<b>Session 7 Chair: Joshua Twining</b>	
09:00-09:20	Martes species' responses to energy developments across the vast western Nearctic boreal forest <i>Jason Fisher</i>
09:20-09:40	Trapping mortality accelerates the decline of the fisher, an endangered mesocarnivore, in British Columbia, Canada <i>Rory Fogarty</i>
09:40-10:00	Pine marten range expansion in the UK: spatial temporal patterns and key influencing factors <i>Keziah Hobson</i>
10:00-10:30	<b>COFFEE BREAK</b>
10:30-11:30	<b>Keynote Lecture 3 Dr Angela Fuller</b> Exploring the lesser-charted territories: conservation challenges and evidence-based strategies for Martes in a changing world
11:30-11:50	An integrated research program aims to solve the conservation dilemma of the American marten in Wisconsin <i>Jonathan Gilbert</i>
11:50-12:10	Current and future challenges for wolverine conservation in Scandinavia <i>Jens Persson and Malin Aronsson</i>
12:10-13:50	<b>LUNCH</b>
13:15-14:15	<b>Martes Recovery Planning Panel</b>
14:15-14:45	<b>COFFEE BREAK</b>
14:45	<b>Closing Remarks</b>



# Symposium Abstracts

Yellow throated marten: ©Cloudtail the Snow Leopard



# Using diversionary feeding to reduce nest predation and relieve conservation conflict

J. Bamber<sup>1\*</sup>, K. Kortland<sup>2</sup>, A. Payo-payo<sup>1</sup>, C. Sutherland<sup>3</sup>, X. Lambin<sup>1</sup>

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<sup>2</sup>Forestry and Land Scotland, Inverness, Scotland

<sup>3</sup>University of St Andrews, St Andrews, Scotland

**Keywords:** *diversionary feeding*; *conservation conflict*; *nest predation*; *pine marten*; *capercaillie*

Nest predation is highlighted as a key issue in ground nesting bird conservation. Often lethal control of predators is recommended as the solution to lower predator numbers and relieve any additive predation pressure. When predators in the system are protected and also of conservation concern, this can cause conservation conflict, where management for one protected species may involve negative intervention with another.

In Scotland this possible conflict is seen with capercaillie, *Tetrao urogallus* and pine marten *Martes martes*, with some calling for direct intervention on pine marten. Our work evaluated non-lethal predator intervention via diversionary feeding (deliberate provisioning of alternative food) to allow positive conservation of both predator and prey. Research was performed across two bird breeding seasons using a large scale field experiment (600ha) within the Cairngorms. Experimentation took place in a control and test design, using false nests as an index of predation pressure.

Findings show pine marten as the most likely nest predator, but also show that the presence of feeding can effectively reduce overall nest predation rates by ~30%, indicating that diversionary feeding is likely a good tool for land managers to utilise for non-lethal predator intervention.

## References

- Kubasiewicz, Laura M., *et al.* 'Diversionary feeding: an effective management strategy for conservation conflict?' *Biodiversity and Conservation* 25.1 (2016): 1-22.
- Finne, Mats H., *et al.* 'Diversionary feeding of red fox in spring increased productivity of forest grouse in southeast Norway.' *Wildlife Biology* 2019.1 (2019): 1-12.

# How to avoid the camera TRAP: recommendations for effective use of remotely triggered cameras

Jody Tucker<sup>1\*</sup>, Katie M. Moriarty<sup>2</sup>, Jessie D. Golding<sup>1,3</sup>, Jordan Heiman<sup>1,3</sup>, Martha Ellis<sup>4</sup>, Brent Barry<sup>5</sup>

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**Keywords:** *camera trap; Pacific marten; fisher; sampling design*

Camera traps have become a ubiquitous survey tool for many wildlife species, especially for species like members of the *Martes* complex that can be challenging to study due to their rarity on large landscapes, high rates of movement, or elusive behavior. However, there are many factors in study design that influence the efficacy of camera data. We aggregated camera trap data from thousands of camera stations across multiple large-scale camera trapping studies in the western USA studies to evaluate factors influencing the efficacy of camera study design for research on fisher, marten, and other co-occurring carnivore species.

In particular we focus on two aspects of camera studies. First, we address the issue of camera trap settings and how camera settings such as trigger-delay interval and number of photos per trigger (burst), affect species detectability and occupancy estimation. As these two settings determine the number of photos a camera generates, they not only influence detectability but also the time and labour cost associated with processing photos. Non-optimal settings that are too low could result in inability to detect species but conversely, settings that are too high may generate extraneous photos that only serve to increase workloads for photo processing and data management.

Second, we evaluate the issue of effective sampling area for camera traps. Studies often assume a single camera can sample a large area (eg, sampling a 25-100 km<sup>2</sup> grid cell) when the actual effective sampling area of each camera may be much smaller. The effect of a limited effective sampling area for cameras (and other passive survey devices) has received little attention to date, despite being flagged as a critical issue. Our results provide insight on how to optimise camera study design to ensure sufficient species detectability while minimising extraneous sampling and photos that can lead to unnecessarily high workloads in camera data management.



# Wolverine ecology at the southern edge: influence of snow cover, temperature and human activity

Malin Aronsson<sup>1\*</sup> and Jens Persson<sup>1</sup>

<sup>1</sup>Grimsö Wildlife Research Station, Dept. of Ecology, Swedish University of Agricultural Sciences, SE-73091 Riddarhyttan, Sweden. [malin.aronsson@slu.se](mailto:malin.aronsson@slu.se)

**Keywords:** *global warming; conservation; reproduction; scavenging; caching*

The wolverine (*Gulo gulo*), adapted to a life in the cold, remote and unpredictable environments of the tundra and taiga in Eurasia and North America, is often portrayed as a secretive creature of the northern wilderness. Throughout their range, several challenges are raised regarding current and future wolverine conservation. These include human disturbance, habitat fragmentation, depredation conflicts, as well as decreasing snow cover due to global warming. Following their recent recolonisation of south-central Scandinavia, wolverines have now reached what is believed to be the southern periphery of their historical distribution in the early 19th century. However, during the 200 years of wolverine absence, this area has undergone drastic environmental changes, several of which might have negative consequences for wolverines.

Therefore, we have initiated studies of wolverine ecology in relation to snow, temperature and human impact in this southernmost part of the population. Currently we base our results on ten years of data from 45 GPS-collared wolverines and data from the Scandinavian monitoring programme. As a consequence of the southward expansion, the relationship between the distribution of wolverine reproductions and persistent spring snow cover has diminished. At the den site scale, wolverines use structures, such as boulders, providing protection in rugged terrain. Although wolverines prey upon small prey during the summer, the vast majority of their diet consists of scavenging on ungulate remains, mostly provided by human activity.

Although most food resources originate from the autumn moose hunt, their caching behavior enables wolverines to use of this throughout the year. High summer temperatures may influence wolverine activity – however, food caches are located at sites maintaining refrigeration even when ambient temperature reaches 25-30° C. In this southern part of their distribution, about 90% of adult females are reproducing, which is the highest wolverine reproductive rate recorded throughout Eurasia and North America.



# Factors influencing winter rest site selection and energetics of American martens

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**Keywords:** *American martens; thermoregulation; energetics; snowpack*

During winter, thermoregulation is energetically costly to boreal forest martens due to their elongated bodies, lack of fat stores, and relatively short fur. In response, martens generally select rest sites under snow where they experience relatively warm temperatures that allow them to reduce heat loss and minimise energy expenditure. Over the last 50 years, the extent, duration, and depth of snow cover has declined, and martens may not have access to thermally protective rest sites under snow in areas where the snowpack is deteriorating. In areas with shallow, transient snowpack, martens tend to rest in tree cavities during winter, but the energetic consequence of this switch is not well understood.

Our objectives were to evaluate how differences in climate, snowpack and tree cavity characteristics influence winter rest site selection by American martens and how these differences affect marten energetics. We compared marten rest site selection and thermal properties of rest sites and estimated energy expenditures between two study areas: the lower peninsula of Michigan, USA, where there is limited snowpack and martens primarily rest in tree cavities during winter, and northeastern Minnesota, USA, where the snowpack is deep and martens primarily rest under the snow during the winter.

Selection for tree cavities in Michigan appears to be driven by shallow snow depths and warm ambient temperatures, low availability of subnivean microsites, or both. Nonetheless, our energetic model suggested martens would save energy had they rested in the snowpack. In Minnesota, deep snow and cold ambient temperature conditions make subnivean sites ideal for resting throughout winter. The energetic cost of resting under the snow in Minnesota was similar to the cost of resting in tree cavities in Michigan, suggesting that martens may not suffer large energetic costs when switching rest sites to tree cavities where snowpack is deteriorating.

# A unique population of fishers (*Pekania pennanti*) threatened by rapid habitat change

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**Keywords:** *Pekania*; fisher; climate change; fire; California

An isolated population of <400 fishers (*Pekania pennanti*) in the southern Sierra Nevada mountain range, California, USA, is threatened by climate change and a rapid increase in large, severe wildfires. Whereas fishers elsewhere occupy temperate forests, this southernmost population is unique in occupying Mediterranean climate conditions. Years of intensive research and planning had culminated in a comprehensive conservation strategy for the population in 2016 (Spencer *et al.* 2016), but the strategy immediately became unworkable due to rapid habitat changes.

Beginning in 2014, extended drought and insect outbreaks began killing tens of millions of trees in the region, including many of the large pines (*Pinus* spp.) fishers use for denning and resting. Concurrently, historically large, severe wildfires have burned more than 50% of fisher habitat in the past ten years, removing forest cover over huge areas. This loss of forest cover removes essential fisher resting and denning structures and increases the risks of predation by larger carnivores. Remaining habitat areas are becoming unconnected, separated by open landscapes that may be too wide for fishers to cross. Compelled by these rapid changes, the Sierra Nevada 'Distinct Population Segment' of fishers was listed as Endangered in 2020 under the US Endangered Species Act.

The survival of this unique, southernmost population of fishers has become highly uncertain as scientists and land managers try to understand these changes and to develop management actions to stem the habitat and population losses. I will present the most recent scientific findings and conservation actions being taken to help recover this endangered fisher population.

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# Beyond brotherhood: non-kin alliance among male yellow-throated martens (*Martes flavigula*) in Taiwan.

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**Keywords:** *sociality; male association; kinship*

While the yellow-throated marten stands out for its unique group hunting behaviour among members of the Mustelidae family, little is known about their social structure and behaviour. This study focused on the population of yellow-throated martens in the Tataka Recreation Area, located within Yushan National Park in Taiwan, with the objective of examining the organisation of their social groups.

From 2019 to 2022, 39 individuals (25 males and 14 females) were tagged and tracked using VHF or GPS collars. Interactions between group members were recorded through radio telemetry, camera traps, and sightings reported by tourists. The genetic structure of the population was assessed using 12 microsatellite markers to evaluate relatedness within and between groups.

Among the adult males, more than 90% of the individuals were observed foraging with another male, and six out of seven pairs with genetic data available from both sides were found to be unrelated. Our findings demonstrated a strong inclination for two unrelated male yellow-throated martens to form foraging groups, exhibiting fidelity to their hunting mates. Male dyads were commonly observed throughout the year, typically consisting of an adult male and another adult or subadult. The formation of male dyads could remain stable for months to years unless a partner dropped out of the group due to injury or death. During the mating season, dyads would temporarily become triads when solitary females joined. Although the aggregation of male carnivores has been mentioned in some studies, sociality between non-kin males was rarely described, and the advantages of such aggregation require further examination.

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# Space use and abundance of Humboldt marten and their competitors in Northern California

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**Keywords:** *competition; Humboldt marten; SCR; space use*

The Humboldt marten (*Martes caurina humboldtensis*) is a genetically distinct subspecies of the Pacific marten (*Martes caurina*) facing conservation concern. There are four known contemporary populations across coastal Oregon and Northern California, each presumed to be at risk of extinction due to their small size and isolation. Despite efforts to better understand their contemporary distribution and habitat associations, little is known about the abundance and interspecific relationships of Humboldt martens across their current range.

To fill these gaps, we deployed 288 non-invasive hair snares and 132 remote trail cameras across three sampling grids in the North Coastal California Extant Population Area from August-November 2022. Genetic samples collected at hair snare stations were identified to individual and those that were identified as marten were subsequently genotyped to sex and individual. With the use of single season occupancy models and spatial capture recapture models we estimated the space use and abundance of Humboldt martens and their competitors.

These findings provide the first step in understanding Humboldt marten density across a broad range of habitat types, as well as how spatial overlap with co-occurring carnivores may influence marten distribution.



# European pine marten occurrence on Elba island: effects of humans and domestic cats

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**Keywords:** *camera trapping; species interactions; island ecosystem; human disturbance; cat coexistence*

The European pine marten *Martes martes* is widely distributed across Europe and several islands in the Mediterranean region. Although marten's status and distribution have been studied extensively in many parts of the European continent, little is known about island populations and marten's relationship with other species, including humans, domestic and wild animals in insular environments.

We investigated marten's distribution on Elba Island, Italy, where the species is the only wild carnivore present. We evaluated 1 marten's occurrence in response to vegetation type and elevation, 2 whether its distribution was affected by co-occurrence of humans and domestic cats (*Felis catus*), and, if so, 3 whether these co-occurrence patterns were affected by proximity to anthropogenic infrastructures (ie, distances from roads and settlements).

We collected camera-trap data at 77 locations throughout Elba Island in February-July 2020. Using single-season, multi-state occupancy models, we found evidence that martens' occupancy was generally high across all levels of vegetation types and elevation. Martens' distribution was differentially affected by the presence of humans, with positive response to distances from roads only where humans were detected by cameras. Martens' occupancy increased with distance from roads both in the presence and absence of cats but probabilities were higher at sites where cats occurred, indicating a potential selection by both species for locations with similar characteristics. The causes generating this marten-cat co-occurrence pattern deserve further investigation.

Our study shows that, in lack of natural competitors, marten has the plasticity to occur across all the environments and elevations available on Elba Island, but human's presence reduces the probability that some specific areas are occupied. These findings have important management implications and can help identify key areas for marten's persistence.

# No room for fishers: decline in the ability of landscape of British Columbia to support female fishers

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**Keywords:** *British Columbia; fishers; Pekania pennanti; landscape change*

Fishers (*Pekania pennanti*) are rare, forest-dependent carnivores that occur in the low-elevation forests of British Columbia, Canada. The Columbian population of fishers that occurs in the central interior region of the province is at risk of extirpation, where loss of forests needed for reproduction, resting, and movement through timber harvest and wildfire greatly decreases the ability of this species to occupy landscapes. Using data from three radiotelemetry studies, I predicted the suitability of 4,800 territory-sized (30-km<sup>2</sup>) hexagons for female fishers across central British Columbia. I used known territories of radio-tagged female fishers, Mahalanobis distance techniques, and 1:20,000 scale habitat spatial data in 2000 and 2020 to evaluate the change in the ability of the landscape to support female fishers.

Most (91%) territory-sized hexagons within the Columbian population area had densities of denning, resting, and movement habitats with Mahalanobis distance values beyond the maximum observed for radio-tagged female fishers and were considered unlikely to support individual fishers. The number of territory-sized hexagons that were predicted to support female fishers declined from 447 (2000) to 400 (2020) and this loss was concentrated in the Dry Forest and Sub-Boreal moist habitat zones. Given the low total number of predicted suitable territory areas for fishers, the rate of ongoing habitat disturbance, and the rapid projected rate of decline in this population, focused and concentrated habitat conservation measures are needed to ensure the persistence of suitable densities of habitats to support this population into the future.

# From metabarcoding to ecology: adaptive prey switching as a means of coexistence between red foxes and pine martens in Scotland

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**Keywords:** *metabarcoding; pine marten; red fox; prey switching*

Many sympatric predators are known to compete for resources and kill each other. In some instances, this may lead to suppression or exclusion of the subordinate species. However, diverse and abundant predator assemblages are common in nature and, hence, so must be coexistence mechanisms. Adaptive prey switching is one of such mechanisms and may enable coexistence among species with similar ecological niches.

Red foxes and pine martens are two widely sympatric carnivores. Despite foxes being known to kill martens, both have highly overlapping diets in Scotland with no apparent signs of competitive exclusion. In this study, we have analysed vertebrate DNA from a large sample size of fox ( $n = 647$ ) and marten ( $n = 1,060$ ) scats through DNA-metabarcoding to discern patterns of prey switching over a period of changing food availability. We describe the diet and trophic overlap among the two predators over two seasons and years. We also relate spatial variation in the occurrence of main and alternative prey groups to proxies of their availability to infer the importance of adaptive prey switching.

Trophic overlap was high but decreased when their main shared prey was scarce. There was no strong evidence of martens switching out of their main prey shared with foxes, but martens did switch out of an alternative prey. Instead, foxes seemingly switched out of their main prey. Thus, while prey switching occurred, it was the dominant predator, fox, that switched. The spatial distribution of main and alternative prey groups in different habitats, a fragmented landscape, different foraging opportunities for each predator, and the availability of high-value anthropogenic subsidies are all likely responsible for our findings. Thus, while in an expected manner, adaptive prey switching enables close and wide-spread coexistence among red foxes and pine martens despite highly similar trophic niches.

# Red fox and marten, friends or foes? Overlap of diet and spatiotemporal distribution of mesocarnivores in Gorce National Park, Poland

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**Keywords:** *competition; coexistence; camera trap; scat analysis*

Red foxes *Vulpes vulpes* and martens *Martes* spp. typically belong to the same foraging guild. This consequently can induce competition for resources. The dominant species directly influence subordinates, which in turn to avoid competitive exclusion have to specialise their niches, eg, by adapting spatial and temporal distribution or modifying their feeding ecology. The aim of the research was to study the daily activity patterns and dietary habits of martens and red fox inhabiting Gorce National Park.

Scat analysis was used to assess trophic preferences of both species. In total, 23 and 49 scats of martens and foxes were collected between 2014 to 2018. The standardised food niche breadth was higher for foxes ( $B_s=0.55$ ) than for martens ( $B_s=0.41$ ). Although a high Pianka's index ( $Okj=0.95$ ) indicates greater niche overlap, yet the carnivores differed in their prey species. Both martens and foxes consumed predominantly rodents. While martens preyed on bank voles *Myodes glareolus*, foxes preyed more on yellow-necked mice *Apodemus flavicollis*. Martens consumed more birds, whereas foxes consumed more invertebrates. Ungulate carrion was only present in foxes' scats indicating that they extensively supplemented their diet.

In parallel, we conducted monitoring with the use of camera traps. The total number of analysed records of red foxes and martens was 458. Pine marten and red fox had a high activity overlap ( $\Delta=0.87$ ) and majority of records were nocturnal. During the five years, pine marten was mostly recorded in summer (35%) and autumn (32%), while fox was mostly recorded in spring (41%) and winter (24%). In 23% of locations, both species were recorded but only in nine sites were fox and pine marten recorded fewer than ten days apart from each other. Despite high daily activity overlap and similar diet, it can be concluded that the species decrease their competition level by different activity and dispersal pattern as well as using different prey items.



# Introduction to The Stacks publishing method

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**Keywords:** *peer-reviewed; free publishing; collaborative; open access*

The Stacks frees researchers to collaboratively publish peer-reviewed science. All sound science moves Martes conservation forward, so Martes Working Group members can publish their findings in this year's proceedings as a short or long article – for free. Every article submission will be peer-reviewed by at least 5 experts, both within and external to the Martes Working Group, who will collaborate to vet and improve the research in a double-blind peer review. All articles published in this year's proceedings will always be open-access, assigned DOI's, and indexed in scholarly databases. With The Stacks, the Martes Working Group will be able to easily share the findings from this year's symposium and make the largest impact possible for Martes conservation around the globe.

# Space use and habitat selection by fisher (*Pekania pennanti*) in temperate deciduous forest of Québec

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**Keywords:** *Pekania pennanti*; habitat use; GPS collars; forest management; satellite telemetry

Forests occupied by fisher (*Pekania pennanti*) have been greatly modified by human activities in recent decades. These changes have contributed to shifts in the structure and species composition of forest landscapes, possibly affecting habitat selection of individuals to meet their needs in terms of movement, feeding, and reproduction. In a predominantly deciduous forest matrix, softwood stands appear to be a suitable environment for fisher in winter. These stands retain some of the snowfall and reduce the energy cost of moving in snow.

Our objectives were to characterise space use and habitat selection by fisher in temperate deciduous forest during three periods: the pre-breeding season with snow cover, the breeding season and the post-breeding period without snow cover. Between November 2020 and March 2022, we captured 21 fishers (16 males, 5 females). Each fisher was fitted with GPS/satellite collars (Iridium TGW-4170-4 and Globalstar TGW-4065-4, Telonics, Mesa, Arizona, USA). Individuals were followed during an average of 135 days and 341 locations per animal.

The breeding season was characterised by large movements, for both males and females, between March 12 and April 23, for the two years. Core (50% fixed kernel) and peripheral (95% fixed kernel) home range sizes were both greater during the breeding season than the two other periods, while there was no significant difference in home range sizes between the snow and snow-free periods. For example, the average core area and peripheral area during the breeding period were 74 km<sup>2</sup> and 852 km<sup>2</sup>, respectively. In contrast, average core area and peripheral area during the snow and snow-free period were 21 km<sup>2</sup> and 101 km<sup>2</sup>, respectively. Habitat characterisation for each period is underway and will allow us to better understand the forest attributes sought by the fisher in different seasons.

# The use of tree stratum by tayras (*Eira barbara*) in areas dominated by domestic dogs (*Canis familiaris*)

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**Keywords:** *use of space; temporal avoidance; vertical stratification; canopy; interaction between carnivores*

Competitive interactions can influence population dynamics. The domestic dog (*Canis familiaris*) is an exotic species known to have impacts on native fauna. The tayra (*Eira barbara*) is one of the species that can feel the effects of this interaction. Its scansorial behavior can help to avoid agonistic encounters, using the arboreal stratum or changing the pattern of activities and reducing interference competition.

To test this hypothesis, camera traps were installed at 73 sampling points with two cameras to investigate the verticalisation of space use in an agricultural landscape surrounding a conservation unit. A total of 32 records of tayras and 100 of domestic dogs were obtained. In only eight points did the two species occur simultaneously. As for the activity pattern, the tayra is diurnal, with two peaks of activity around 9am and 3pm, while dogs were more active around 4pm, despite showing nocturnal records as well. The overlapping pattern was 68%, however at the points where both species occurred, the percentage dropped to 43%, and in these places tayra activity was concentrated in the morning while domestic dogs were active throughout the day, including 36.4% of records at night.

Models were generated to explain tayra occupation, the most explanatory of which indicates that the percentage of forest, coffee and perennial plantations are important variables. As for the models with dogs, the percentage of temporary crops and agricultural mosaic influencing positively, while forests negatively. There were no records of tayra captured by arboreal cameras, however, one of the terrestrial cameras captured the moment when an individual exhibits scansorial behaviour climbing a trunk. The sampling point is characterised by having half of its area composed of agricultural mosaic and recorded the presence of a domestic dog.

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# An expert survey to inform regional and global threat assessments and conservation planning for wolverine (*Gulo gulo*)

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**Keywords:** *conservation planning; expert opinion; furbearer conservation; Potential for Conflict Index (PCI2); threat assessment*

Despite being a species at risk, the threats to wolverine (*Gulo gulo*) are not well understood at regional and global scales. Expert opinion may be a useful means of exploring important questions for which field data are not available and may be otherwise difficult to obtain in a timely manner. We developed a comprehensive questionnaire to survey wolverine experts to collect and collate their experiences and beliefs on threats to the species. We obtained completed questionnaires from 33 experts with an estimated 408.5 (range = 271-550) person-years of experience.

Respondents were mixed in whether they believed that threats were well known for wolverine at global or regional scales, with experts collectively indicating better knowledge of regional (63% agreed) versus global (40% agreed) threats. We contrast respondents beliefs on 11 potential threats to wolverines at global and regional scales. Additionally, we explore whether the continent (Eurasia or North America), biome (boreal or sub-boreal), number of years working with wolverine (1-5 versus >5), or local wolverine abundance (low or moderate), influenced respondents' beliefs about threats to wolverine. Moreover, our survey explored respondents' beliefs about appropriate conservation actions for managers to take in ten hypothetical scenarios.

Results from our expert survey illuminate consensus and variability in the beliefs of wolverine experts. By harnessing the collective wisdom of the wolverine research community, our results may provide a robust basis for developing regional or global conservation strategies for wolverine.

# Rewilding apex predators can structure ecosystems through trophic cascades: ecological consequences of losing stone martens in a Mediterranean forest

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**Keywords:** *Iberian lynx; capture-recapture Bayesian models; mesopredator release; spatial-temporal segregation; seed dispersal*

The current scenario of global change demands research on how ongoing ecological disturbances can alter ecosystems. Trophic cascades are powerful mechanisms affecting the entire dynamics of food webs, from predators up to primary producers. Thus, the recent rewilding of large predators worldwide could trigger cascading effects on lower trophic levels, affecting mesopredators and the ecological functions which they are involved in. Here, we investigated how an apex predator which is recovering its distribution range, the Iberian lynx (*Lynx pardinus*), can determine **1** the absolute abundance, **2** the spatiotemporal activity patterns and **3** the seed-dispersal service provided by a frugivore mesocarnivore, the stone marten (*Martes foina*) in a Mediterranean forest of Southern Spain.

We hypothesised that the lynx causes a mesopredator suppression and the predation risk induces an avoidance behaviour, what can negatively affect to the ecosystem function that martens play as seed-dispersers. In order to estimate the effect of lynx on the stone marten abundance and activity, we compared patterns from ten localities with presence or absence of the apex predator using camera-trapping (n=120). Additionally, to evaluate the effect of lynx on the quantity and diversity of seeds dispersed, we collected stone marten scats (n=175) along transects in the same localities for two consecutive fruiting seasons.

We found that stone marten abundance was 10-times lower in sites with lynx and observed a total spatial segregation between these carnivores, although the temporal activity patterns of martens were unaltered under predation risk. The seed dispersal service provided by martens was negatively affected by lynx leading to a markedly reduction of the quantity (7.2-fold) and diversity (2-fold) of seeds mobilised, revealing a novel trophic cascade. Reintroducing apex predators can be a successful though challenging conservation tool and thus unexpected cascading effects should be considered in defaunated scenarios, where mesocarnivores play ecosystem key roles.



# Evaluating population genetic structure of the North American wolverine using microsatellite loci and single nucleotide polymorphisms

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**Keywords:** *microsatellites; single nucleotide polymorphisms; population structure; landscape genetics; landscape genomics*

North American wolverines (*Gulo gulo luscus*) are widely distributed across their northern boreal and Arctic range, where they are commonly hunted or trapped for their valuable and culturally significant furs. However, population declines in their southern range, particularly the northwestern United States have prompted conservation concern. Wolverines are vulnerable to climate change and human development as they are adapted to cold, snowy environments and are impacted by human infrastructure and disturbance.

Investigating gene flow patterns in relation to natural and human landscape features can give insight to wolverine sensitivity to landscape change. Identifying loci under selection across their western range will determine what environmental variables drive local adaptations. Collaboration with hunters and trappers, managers and researchers provided dense sampling of individuals in Alaska and the Yukon (n=540) and clustered regional sampling from Alberta (n=3), British Columbia (n=7), Idaho (n=8), and Montana (n=22). We are comparing nuclear DNA microsatellite and single nucleotide polymorphism (SNP) loci identified via reduced representation sequencing (RADseq) for their ability to detect genetic structure. This is the first North American wolverine study to utilize SNPs, and we expect to delineate more population structure with SNPs than with microsatellites.

All Alaska and Yukon wolverines were genotyped at 12 microsatellite loci and a subset of samples (n=246) were genotyped at 9,759 SNP loci. Bayesian clustering analysis and principal component analysis on the two datasets show that the SNP dataset detects more population structure and more genetic groups than the microsatellite dataset. Landscape genetic analyses will be used to evaluate isolation by resistance and environment hypotheses to identify landscape features associated with patterns of gene flow. Additionally, RADseq data for wolverines sampled in Alberta, British Columbia, Idaho, and Montana will be used in genotype environment association analyses to identify loci under selection across their western range.

# A hierarchical modelling approach to predict the distribution, density, and habitat relationships of fishers in Washington, Oregon, and California

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**Keywords:** *hierarchical modeling; occupancy modeling; species distribution model; fisher; Pekania pennanti*

Fishers (*Pekania pennanti*) are a medium-sized carnivore of conservation concern in portions of their distribution in the western United States (U.S. Fish and Wildlife Service 2016, 2020). Fishers in the southern Sierra Nevada Mountains of California are federally endangered and other populations in the western United States have been evaluated for federal listing on several occasions (U.S. Fish and Wildlife Service, 2020). Small and isolated populations are the most immediate and challenging threat to fisher persistence in Washington, Oregon and California (Naney *et al.*, 2012, Thompson *et al.*, 2020). Species distribution, habitat associations, and population size are critical information needs for species recovery (eg, Carroll *et al.* 2006). Distribution patterns and habitat associations have been evaluated using presence-only and expert opinion models (U.S. Fish and Wildlife Service, 2016).

These models, however, frequently fail to meet assumptions (eg, representative sampling, constant detection probabilities) increasing calls for analyses in detection-non detection frameworks (eg, Yackulic *et al.*, 2013). We are modeling the distribution, density, and habitat relationships of fisher across Washington, Oregon, and California. We developed a hierarchical model of detection-non detection data using occupancy and integrated modeling to estimate these important parameters. Our results will be a useful decision-support tool to promote species recovery in the face of stochastic events and a changing climate.

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# Transforming tech: biological insights from elusive forest mustelids from fine-scale GPS data

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**Keywords:** *GPS data; Pacific marten; fisher; movement; rest*

Members of the *Martes* complex are inherently difficult to study due to their impressive movement rates, large ranges and tendency to rest and den in specific structures, often cavities or chambers. GPS data may seem like a panacea, but the challenge of missed and biased fixes, especially in dense forest cover, deep canyons or cavities can be problematic as even <5% missing locations can bias evaluations of habitat use. Nonetheless, combining GPS locations with other data (eg, VHF locations, accelerometer movement rates) can assist interpretations.

To increase conversations and creativity, we showcase successes and pitfalls from Pacific martens' and fishers' range use, activity, models focused on movement (eg, integrated step selection, Brownian bridges) and rest use patterns (eg, hidden Markov and state-space). We highlight results from several studies using data combinations (nine fishers [>60,000 locations], >70 martens [>30,000 locations]).

Adult martens were often highly territorial, but fishers and subadult martens were less predictable. Adult martens and fishers were often active during periods of increased prey activity, but subadults often partitioned activity during opposite times, making activity data from remote cameras suspect. Step-selection functions and Brownian bridges hold promise for interpreting habitat use, but results varied between individuals. We used hidden Markov and state space models to interpolate missing data as well as spatially identifying resting locations.

From multiple analyses and endeavours, we conclude that GPS technology can provide unprecedented information at fine spatial scales but is not a tool for all challenges due to missed locations and short observations from small batteries. To maximise GPS information gain, combining multiple forms of data provided highest likelihood for biologically relevant interpretations. Independently accounting for individual, sex, and age seems obvious, but modelling is challenged with small sample sizes. We encourage prospective meta-analyses where data can be collected similarly among studies and combined.

# Protocol for coupling automated scent dispensers with camera traps to conduct year-long, overwinter surveys of mustelids and other carnivores

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**Keywords:** *camera trap; scent dispenser; mustelid; monitoring; survey*

Camera traps, combined with baits and scent lures, are a valuable tool for surveying elusive and low-density mustelids and other carnivores. In the northern latitudes of North America, camera-trap surveys for mustelids are often conducted during winter, when detection rates tend to be relatively high and the risk of bait removal by bears (*Ursus* spp.) is low. Winter field research can be labor- and time-intensive, however, and can present challenges to biologists who work in remote, potentially inaccessible mountain locations prone to snowstorms and avalanches – thereby limiting or precluding opportunities for revisits to rebait survey stations.

We developed a survey protocol for wolverines (*Gulo gulo*) in the American West that enables the continuous operation of camera traps for over a year under winter conditions characterised by deep snow, without the need for interim visits by field personnel. The protocol relies on innovative camera positioning and orientation, paired with a recently developed automated scent lure dispenser. Here we present results from three case studies in the U.S. state of Washington, comprising: **1** surveys for wolverines recolonising the Cascade Range, **2** monitoring fishers (*Pekania pennanti*) reintroduced to the Cascades, and **3** assessing the distribution of rare Pacific martens (*Martes caurina*) on the Olympic Peninsula.

Time-to-first detection of wolverines averaged 225 days, suggesting the stations effectively attracted and detected this species many months after deployment. Fishers were detected at 17/38 stations targeting these animals in a 2021-22 pilot study, and most of the very few camera trap images of martens ever captured in the Olympic range have been at stations using this protocol. We also detected black bears (*Ursus americanus*), cougars (*Puma concolor*), wolves (*Canis lupus*), coyotes (*Canis latrans*), Canada lynx (*Lynx canadensis*), bobcats (*Lynx rufus*), and other carnivores, suggesting that our protocol can be used to survey and monitor multiple species concurrently.

# Sociality in unexpected places: using global camera trapping data to test the drivers of social complexity in the Martes complex

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**Keywords:** *martes complex; sociality; camera traps; fisher; marten; wolverine; tayra; resource dispersion hypothesis*

Understanding the evolutionary, physiological and proximal drivers of species observed socio-ecologies is foundational to understanding their ecology. Martens and their close relatives (coined the Martes complex) are exemplary of animals thought to be restricted in terms of sociality and often described as ‘obligately solitary’. However, a number of recent observations of seemingly cooperative behaviours challenge this long-standing assumption.

Here, we collate camera trapping data globally to test the drivers of aggregation and thus social complexity present across the seven species of the Martes complex consisting of four species of true marten and three close relatives: the wolverine, the tayra (*Eira barbara*), and the fisher (*Pekania pennanti*) all included in the Martes complex. We derive a coarse metric, the probability of being detected in a group, as proxy for social complexity, and use a series of binomial generalised mixed effect models to examine the drivers of aggregation on a dataset of over 33,346 independent detections across 14 countries in four continents. We observe a wide spectrum of social complexity across the Martes complex with the probability to aggregate in groups varying by over an order of magnitude across the species. We find clear support for critical interactions between physiology (eg, fat storage capabilities to buffer against periods of resource scarcity) and resource availability, predictability and dispersion in the environment, as the key drivers of aggregation.

We challenge the idea of Martes as obligately solitary species and make the case that while species may be predisposed to a certain level of sociality, no species is inherently solitary or social, with a dynamic spectrum of environment-dependent sociality possibly exhibited by any single species. Failure to recognise this not only limits our understanding of the individual species, but both the causes and consequences of sociality and group living.



# Martes species' responses to energy development across the vast western Nearctic boreal forest

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**Keywords:** *landscape change; American marten; fisher; wolverine; conservation*

The western Nearctic boreal forest spans 100,000's of square kilometers and is changing rapidly with extensive energy development and forest harvesting, in ways without historic or contemporary global analogues. Home to multiple species in the *Martes* clade, the transformation of this vast and complex landscape has changed risks and resources for those species. Habitat loss and fragmentation are obvious mechanisms for *Martes* populations. Less obvious but more illuminating is the interplay between *Martes* species and their predators and competitors, and interactions between landscape and climate change.

Synthesising a score of studies over as many years, I illustrate how landscape and climate change have altered spatial and temporal interactions among *Martes* species and predators, and how this knowledge yields insights into the mechanisms of landscape change for mammals generally. I discuss how these insights are gained through the evolving large collaborative Oil Sands Monitoring program, and how conclusions are adopted by government and industry to inform conservation planning for *Martes* and other species.

# Trapping mortality accelerates the decline of the fisher, an endangered mesocarnivore, in British Columbia, Canada

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**Keywords:** fisher; *Pekania pennanti*; trapping mortality; population modeling; extirpation

Understanding the environmental, demographic and anthropogenic factors driving the population dynamics of endangered species is critical to effective conservation. Habitat loss, fragmentation, and trapping all have been linked to declines in the endangered population of fishers (*Pekania pennanti*) in central British Columbia (BC), Canada, hereafter referred to as the Columbian population. Although the commercial trapping season for fishers has recently been closed in central BC, the animals are still taken in traps legally set for other furbearer species, and with this continuing source of mortality, the sustainability of this vulnerable population remains unclear.

We constructed population viability models in the program Vortex to evaluate the specific impacts that trapping mortality would have on Columbian fisher population persistence under different trapping scenarios. Our modeling predicted that current mortality sources, including deaths in traps set for other species, will cause the population to disappear within 11 years. When fur harvest mortality was removed from our modeling, the Columbian population appeared unlikely to persist beyond 37 years.

Our analysis provides evidence that along with the continued trapping closure for fishers in central BC, it is likely necessary to modify trapping regulations and methods (including restricting the use of kill traps) for other furbearers within Columbian fisher range to sufficiently reduce mortality from bycatch and help to avoid extirpation of the population in the near future. Additionally, identifying areas where fishers are actively breeding and protecting these habitats from further disturbances will be needed to increase survival and reproductive rates to levels high enough to reverse population declines over the longer term.

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# Pine marten range expansion in the UK: spatial-temporal patterns and key influencing factors

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**Keywords:** *pine marten; range expansion; recovery; human persecution, occupancy*

The pine marten population in the UK suffered dramatic declines in the 19th and 20th centuries resulting in the largest remnant population on the mainland restricted to the northwest of Scotland. Since the 1980s, the pine marten population in the UK has been recovering, however natural range expansion has been slow, with parts of Scotland still unoccupied and only a few records from Northern England. To date, there is a lack of clarity in the spatial-temporal pattern of range expansion across Scotland and Northern England, and the factors influencing it. Without a clearer understanding of the factors supporting or impeding expansion of a native predator, it is difficult to design effective land management and agricultural policies that promote recovery.

In this study we combine data collected through multiple repeat field surveys that detected pine marten to characterise expansion from 2013 to 2021 using an occupancy modelling framework. Variables falling under three key themes: habitat, human-related (eg, roads) and human persecution (eg, proxies for gamebird and grouse management, and persecution events) were selected and tested. Proportion of woodland at a landscape and home-range scale density of all road types (including motorways, primary and secondary), and distance to large gamebird shoots were important for pine marten occupancy and range expansion. These findings provide valuable insight into the rate of range expansion and the factors acting as barriers or promoting expansion and are useful for designing future conservation activities for both natural and assisted recovery of pine martens in the UK.

# An integrated research program aims to solve the conservation dilemma of the American marten in Wisconsin

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**Keywords:** *climate change; competition; conservation; fisher; marten; Wisconsin*

The American marten is classified as an endangered species in Wisconsin, featuring <300 individuals in three relatively isolated populations. Martens face challenges: individual populations are small, distributed across a wide geographic area and inhabit forests that are structurally simpler than historically. We found that marten persistence could be improved with the addition of a single marten immigration event per year. Nevertheless, movement modeling shows that potential movements from secure populations are unlikely in one of the two Wisconsin populations.

Unsurprisingly, marten populations in the Great Lakes region are highly structured genetically with implications for augmentation and immigration events. We show that augmentation events in Wisconsin have had negligible effects on marten viability. Martens are subsisting on poor diets and their diet overlaps significantly with that of the fisher, suggesting competitive interactions. Habitat simplification has resulted in niche compression leading to even more competition between martens and fishers. Snow is an important driver of marten persistence as deep snowpack and elevation can reduce co-occurrence of fishers and martens reducing competitive overlap and increasing marten survival. Snow quantities and qualities are, however, predicted to wane as the climate warms, with direct and negative consequences for martens.

Martens were found on the Apostle Islands in 2014 which is good news. We have now documented 43 martens living on five of the islands at densities ranging from 0.42-1.46 martens/km<sup>2</sup>. Martens move from the islands to mainland, and the Apostle Islands may act as a refuge for martens along their range boundary. Martens are at the edge of their range in Wisconsin and changes in land use and climate are all putting negative pressure martens. Despite the challenges imposed by climate and land-use change the identification of refugia, establishment of movement corridors and increasing structural diversity can help to mitigate these negative trends.

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**Keywords:** *management; depredation; demography; harvest*

Wolverine (*Gulo gulo*) conservation and management in Scandinavia is largely focused on mitigation of depredation conflicts and attaining conservation goals influenced by international directives. In both Sweden and Norway, wolverine predation on reindeer causes economic losses for indigenous Sámi reindeer-herding communities, and in Norway wolverines frequently prey upon free-ranging domestic sheep. Sweden and Norway share one continuous wolverine population, although about two-thirds reside in Sweden, and population monitoring is coordinated between the countries.

However, both national population goals and two main means of conflict-mitigation, compensation for depredation and harvest strategies, differ considerably between the countries. Compensation for losses are paid in relation to documented damage in Norway, while reindeer herders in Sweden are compensated in relation to presence of primarily registered wolverine reproductions. The latter provides protection for reproductive females and is suggested to have contributed to population recovery. Annual harvest of wolverines is about 6 times higher in Norway than in Sweden, creating a source-sink system where immigration from Sweden compensates for harvest in Norway, which complicates attainment of national goals in both countries. Thus, management requires knowledge which has motivated long-term research.

We have shown that infanticide (presumably male sexually-selected) is the most common cause of juvenile mortality and that poaching is the most important cause of adult mortality in Sweden, which both complicates our understanding of the effects of harvest. Annual harvest decisions are based on results from models using monitoring data and demographic data from the research project. In addition to information on predation rates and its effects on reindeer herds, we have provided knowledge about the significance of interactions between wolverines and other carnivore, eg, Eurasian lynx has a positive impact on food resources for wolverines and thus, their reproduction.



# Symposium Rapid Fire Talks





# Thinking outside of the box: reducing bycatch of the endangered fisher in marten box traps

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**Keywords:** *fisher; marten; bycatch; trapping; modified marten traps*

Fishers (*Pekania pennanti*) are a medium-sized mustelid found only in North America. The Columbian population of fishers in British Columbia's central interior was provincially listed as Endangered<sup>1</sup> primarily as a result of habitat loss. In 2021, all commercial trapping seasons for fishers were closed, but fishers are still incidentally harvested in traps set for marten (*Martes americana*). This incidental harvest of fishers is accelerating the Columbian population's decline, and continued unmitigated bycatch is projected to result in the extirpation of the population within 11 years (by 2032)<sup>2</sup>.

One method to reduce bycatch of fishers, while continuing to trap for the more common marten, is to use a modified marten box. This box – 'Fisher Exclusion Box' – was designed by our team of biologists in partnership with trappers, and features an elongated marten trapping box with a front face plate. The front face plate opening is sized to effectively exclude fishers from accessing the trap by their larger cheekbone diameter, while still allowing martens to enter.

Presently, the use of the Fisher Exclusion Box is voluntary and replacing existing marten boxes on traplines is cost prohibitive for many. The Fisher Exclusion Box program strives to reduce incidental bycatch by increasing the use of the Fisher Exclusion Box by trappers by **1** reducing the cost barriers limiting its uptake, **2** evaluating its capture efficiency, and **3** communicating the program and its results widely.

From our preliminary results evaluating capture efficiency, the Fisher Exclusion Boxes have continued to effectively eliminate all incidental fisher harvest, while in standard marten boxes two fishers were caught as bycatch during the monitoring period. The capture rate of martens in Fisher Exclusion Boxes (3.09 captures per 100 trap-nights) was also similar to that of standard marten boxes (2.92 captures per 100 trap-nights), suggesting no change to marten capture efficiency.

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# Gaining traction on conservation action: modifying human behaviour for fisher habitat conservation

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**Keywords:** *Pekania pennanti*; habitat conservation; human behaviour; extension

In the world of conservation biology, how do we turn knowledge into action? Effecting conservation action often requires changing the behaviour of the people whose decisions on the landscape are impacting the species we are trying to conserve.

Extension is an informal educational process directed towards a target audience with the objective of changing their knowledge, skills, and attitudes to bring about desirable change in their behaviour. The British Columbia Fisher Habitat Working Group has applied an extension framework to disseminate the findings of over thirty years of fisher (*Pekania pennanti*) research across the province to enhance the capacity of forestry practitioners to maintain fisher habitat throughout the timber harvesting process.

By identifying our target audience, developing conservation tools and guidance specific to their abilities, and disseminating our knowledge of fishers and the role that forestry can play in maintaining fisher habitat, we have facilitated forestry practitioners to incorporate fisher habitat needs into their decision-making process. Throughout this process, we have also identified limitations to turning knowledge, skills, and abilities into voluntary change, with important considerations

# Coexistence and competition in sympatric martens within the western Italian Alps

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**Keywords:** *coexistence; competition; habitat selection; diet; activity pattern*

Pine martens (*Martes martes*) and stone martens (*Martes foina*) are generally considered the most similar carnivores in Europe: indeed, they are very similar in terms of morphology, feeding habits and habitat preferences. Apparently breaking the competitive exclusion principle, however, their distribution ranges largely overlap throughout most of continental Europe, and several syntopic populations have been reported – both martens, for example, extensively occur throughout the Alps.

In 2019-20 we conducted the first faecal DNA-based genetic survey of sympatric martens in the western Italian Alps, carried out in along linear transects (mean  $7.0 \pm 2.0$  km) in 30 randomly selected squares (10x10 km<sup>2</sup>). The two species were recorded to coexist in 30% of the study area. Pine martens strongly selected wet coniferous forests, while stone martens preferred hotter broadleaved forests. Mixed forests seemed to enhance the chance of co-occurrence. Food niche overlap was relatively high ( $\alpha = 0.7$ ), although stone martens ate more fruit than pine martens, which conversely consumed more small mammals. Since spatial and food niche partitioning resulted slight, we argue that other forms of niche partitioning may explain their coexistence.

Therefore, we plan to survey by camera-trapping an area where both species have been recorded. This will allow us to investigate their use of space at the meso-habitat level and time partitioning, highlighting the mechanisms that relax interspecific competition and allow their coexistence. Overall, we think that such a hybrid approach, including both genetic analyses and camera-trapping, may be the most effective in studying such elusive and low-density carnivores as martens.

# Re-examining coarse-filter management approaches: opportunities and costs for recovering British Columbia's endangered fishers

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**Keywords:** *fisher; coarse filter; conservation; biodiversity, Pekania pennanti*

Like other species in the *Martes* clade, fishers in western North America are habitat specialists and their populations are impacted by changes in the distribution and abundance of habitats needed to survive and reproduce. For the endangered Columbian population of fishers occurring in central British Columbia, previous habitat conservation efforts have relied upon coarse-scale approaches where general measures to conserve biodiversity were believed to conserve sufficient habitat for the species to persist. Recent pronounced declines within this population, however, suggest that these coarse-scale measures are insufficient and are in fact driving the population towards extinction. To resolve such conservation challenges, British Columbia relies on piecemeal 'fine-filter' land management approaches that attempt to reactively address one species or value at a time. Unfortunately, this approach has resulted in 'exhausted forests'<sup>1</sup> and professional forest managers who are also fatigued from having to navigate the complex set of regulations and overlapping land designations.

In this study, we assess if existing coarse-filter management policies can be modified to improve Columbian fisher habitat while maintaining economic viability to industries such as forestry. We hypothesised that adjusting the existing coarse-filter management policies can be a cost-efficient approach to recovering fisher habitat while maintaining a modest amount of disturbance. To adjust the existing coarse-filter approaches we quantified the determinants of current fisher habitat availability using logistic regression. The usefulness of this approach was then tested with a forest harvest simulator by comparing the opportunities and costs of achieving fisher habitat characteristics.

Our results highlight that a re-examination of existing conservation policies using determinants of current habitat can identify cost-efficient mechanism for achieving fisher habitat recovery objectives.

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# Scaling up from site to region: predicting fisher responses to landscape change

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**Keywords:** *fisher; individual-Based Model; SpaDES; predictive modelling; forest harvesting*

Fishers (*Pekania pennanti*), a close relative of wolverines and martens, are declining and at high risk of extirpation in the Central Interior of British Columbia, Canada, due to extensive habitat disturbance from forest harvest. A lack of coordinated landscape level planning has led to diminishing opportunities to maintain the limited remaining habitat.

To quantify responses to different management scenarios, we combine Individual-Based Modelling with spatially discrete event simulations (SpaDES) to follow generations of individual fishers through key life-history stages. By ‘scaling up’ existing knowledge that describes individual fisher habitat relationships, these models allow us to evaluate, understand, and predict changes to local fisher populations caused by management decisions (eg, trapping closures, forest harvesting and development, designation of conservation areas).

To support sustainable populations of fishers into the future, we are using this modelling approach to: **1** understand the amount and arrangement of forests fishers need; **2** guide decision-makers when identifying areas for development and protection, that minimise disturbance and maximise protection of fisher habitat and populations; and **3** guide the retention of fisher habitat in timber harvest allocations so that sufficient habitat is conserved at regional scales.

# Site occupancy by American martens and fishers in temperate deciduous forests of Québec

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**Keywords:** *camera trap; interspecific interactions; local knowledge; temperate deciduous forest; trappers*

Recent observations by trappers revealed that American marten populations were decreasing while fisher populations were increasing in temperate deciduous forests of Québec. We aimed to assess the availability of habitat for each species and interactions between the two species. We investigated site occupancy by both species using a network of 49 camera trap stations monitored over two fall seasons at spatial grains of different sizes. We formulated hypotheses on the spatial distribution of the studied species based on local trapper knowledge and on the published papers regarding forest cover composition, habitat fragmentation, and competitive relationships, predicting that given their larger size, fishers have a competitive advantage over martens. We used two-species site occupancy models to quantify habitat use and the influence of fishers on martens at spatial grains of different sizes.

During the fall, site occupancy by American martens in temperate deciduous forests of Québec was independent of fisher site occupancy. None of the habitat variables that we considered explained site occupancy by fishers. However, marten distribution varied with the availability of dense old coniferous stands both at the home range and at the landscape grain sizes. The knowledge of trappers highlighted the importance of stand composition, height, age, and canopy closure. Our study was replicated in winter conditions for two additional field seasons to compare with our sampling of the fall season and help interpret our results.

# Use of footprint identification technique (FIT) to develop a novel tool for species and sex discrimination of fisher tracks

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**Keywords:** *footprint morphometrics; track identification; Pacific marten; fisher; non-invasive sampling*

Footprint identification technique (FIT) is an emerging non-invasive tool in wildlife conservation that has been adapted for a wide variety of species. FIT enables classification of footprints using a geometric profile generated through computer software with a simple graphical user interface. Here we report the development of novel application of footprint identification technique (FIT) for species discrimination for fisher (*Pekania pennanti*) and marten (*Martes caurina*), and sex-ID for fisher. We developed FIT using footprint images collected from free-ranging animals at track plate stations that were identified to individual and sex via genotyping of non-invasive genetic samples.

We developed a reference dataset of 165 marten tracks and 267 fisher tracks (27 females, 34 males). Geometric profiles for each track were extracted using a specialised FIT add-in developed for fisher in JMP data visualisation software. We used a linear discriminant analysis to analyse these geometric profiles and create discriminant functions for species and sex ID. Classification accuracy for both species and sex ID was >90%. FIT provides a promising new tool for fisher research and monitoring by providing a simple and cost-effective method for non-invasive species or sex identification.

## Early winter activity: some days in the life of a fisher (*Pekania pennanti*)

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**Keywords:** *Pekania pennanti*, activity, accelerometer

Who never wanted to be a small mouse to see how our study species live in their daily life? New technologies like accelerometers now make it possible to track daily activities and offer the opportunity to include difference among individuals in habitat selection studies. In 2013 and 2015, we installed radiocollars on female fishers in Quebec, Canada. Despite a poor experience with them, we could collect accelerometer data from four collars for 12 to 26 days during November (N = 3) and December (N = 1) months. E-obs GmbH tri-axial accelerometers were scheduled to record at 1 Hz in a short (82-sec) burst every five minutes. From these few data, we explored the influence of the daily minimum temperature on fisher activity. We calculated statistical variance of the measurements along Z-axis and used thresholds that delineated three activity levels (resting, medium- and high-intensity) as defined by Brown *et al.* 2012.

Fishers were more active between 7:15 and 13:30 and spent 66% time resting in November. Mean length of active bouts was 215 minutes and mean length of resting bouts was 311 minutes. Typically, fishers have two or three active and three resting bouts per day. We noted no effect of the temperature on the percentage of time resting, length of active and resting bouts, and only a small effect on the number of active bouts per day when temperature is higher than -12°C. When temperature is below -12°C, percentage of resting time increased, number of resting bouts decreased, but their length increased in December. This study using raw accelerometer data gives detailed information on how fisher adapt their behavior to climate conditions. By crossing this information with GPS locations, we could link activity and habitat use and better define the habitat needs of fisher in a context of climate change.

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# Modeling habitat suitability and connectivity for the endangered yellow-throated marten in South Korea

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**Keywords:** *landscape permeability; network analysis; roadkill; wildlife corridor*

The yellow-throated marten (*Martes flavigula*), an endangered species in South Korea, plays a crucial role as an apex predator in the country's temperate forest ecosystem. However, human activities continue to pose threats to marten populations and there is a lack of understanding regarding critical habitats and the importance of connectivity for their survival.

This study aimed to address these concerns by developing models of habitat suitability and connectivity networks for the yellow-throated marten. To achieve this, we employed an ensemble of five species distribution models, namely boosted regression trees (BRT), generalised linear models (GLM), multivariate adaptive regression splines (MARS), maximum entropy models (MaxEnt), and random forest (RF). These models helped us identify the key environmental factors influencing marten distribution and potential suitable habitats. Our approach included a network-based landscape lattice combined with circuit theory to predict potential habitat linkages for martens. Additionally, we investigated their relevance to marten roadkill, which provided valuable insights for comprehensive landscape conservation strategies.

The results showed that all five species distribution models performed well, with test area under the curve (AUC) values ranging from 0.809 to 0.826 (mean = 0.820) and true skill statistic values over 0.5. Elevation and vegetation cover emerged as the most significant factors influencing marten occurrence probability, both having a positive influence. Moreover, distances from human settlements and roads were positively related to occurrence probability. By determining appropriate spatial resolutions for conserving functional habitat linkages, we were able to identify key areas crucial for maintaining ecological processes and reducing marten roadkill.

Our findings provide valuable information for understanding and prioritising habitats and linkage areas in species conservation and landscape management efforts. In conclusion, this study effectively identified potential marten habitats and connectivity patterns at regional and functional levels. The presented results and methodologies offer valuable insights into preserving the yellow-throated marten's population.



# Resolution revolution: how high-resolution spatial data help detect winter edge effect for American marten

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**Keywords:** *edge effect; Martes Americana; LiDAR; Spatial ecology; Clearcut*

American martens (*Martes americana*) are thought to be sensible to forestry practice mainly because they avoid large open areas such as clearcuts. However, it is still unclear how opening edges affect martens since they could represent both foraging opportunity, exposure to predation and to severe weather. This lack of information is especially true for smaller gaps' edges undetectable with low-resolution spatial data.

We compared estimated responses of martens and two important winter prey species, snowshoe hares (*Lepus americanus*) and squirrels (*Tamiasciurus hudsonicus*), to forest edges in southern Quebec, Canada based on high spatial resolution data from Light Detection And Ranging (LiDAR) vs. low-resolution photo interpretation. We defined edges of open areas as roads, clearcuts, natural gaps, lakes, or rivers. We geolocated snow tracks along a systematic grid of transect lines, between 2009 and 2018. We compared distances of snow tracks and reference points along transects to the nearest edge with linear models.

Martens and prey species were all avoiding clearcut/gap edges according to LiDAR data while photo-interpreted data failed to detect them. We were unable to detect responses to river, lake or road edges for any species. These results highlight the importance of precise and fine scale delineation of edges to get a proper comprehension of edge effect on martens.

# Using limiting factors to guide landscape-scale management and recovery of *Martes*: examples from two subspecies of the Pacific marten

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**Keywords:** *Martes*; marten; female; limiting factor, recovery

Recognising the role that limiting factors have in determining population responses in species of management and conservation concern is fundamental for identifying management and conservation actions likely to increase population sizes. Prior marten viability and life cycle analyses have demonstrated the importance that adult females and their survival have on population growth and resiliency. Factors limiting adult females or their survival will therefore have the greatest potential to limit marten population sizes and growth.

To identify examples of limiting factors for adult females, two contrasting landscapes were evaluated: 1 a well-distributed *Martes caurina sierrae* population in fire-prone forests managed primarily for recreation 2 an imperilled population *Martes caurina humboldtensis* in a landscape managed primarily for timber production. Samples of the *M. c. sierrae* population revealed a male-biased sex ratio of 1.9 M:F and corresponding male density 2.1 to 3.3 times higher than females. Female density was most influenced by large patches of late-seral forest that is currently limited in that landscape, while male density was influenced equally by both late- and mid-seral forest which is abundant. Dynamic landscape modelling revealed more suitable habitat for females will be recruited in 1-3 decades unless high-severity wildfire continues to occur, emphasising the need to direct management actions to reduce the risk of high-severity wildfire in currently habitat.

Like *M. c. sierrae*, sex-specific analysis of *M. c. humboldtensis* demonstrates that females are more selective for large patches of late seral forest than males. In addition, predation has emerged as a limiting factor for both sexes, suggesting that both suitable habitat and presence of predators are limiting factors. Implementing conservation and management actions focused on limiting factors for females in both landscapes, increasing suitable habitat for females and reducing predators for *M. c. humboldtensis*, will likely have the greatest impacts on population resiliency and recovery.

# Behaviour of wild-caught fishers (*Pekania pennanti*) in captivity prior to translocation

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**Keywords:** *personality; reintroduction; boldness; exploration*

The fisher (*Pekania pennanti*), a mid-sized carnivore in the weasel family, is globally considered secure but has experienced regional declines and local extirpation in many parts of its range, including in Washington State. As part of the conservation translocation program to re-establish Washington's fisher population, wild fishers from a source population in Northern Alberta, Canada were captured by licensed trappers during October to February in 2018 and 2019 and temporarily housed at the Wilder Institute Calgary Zoo to undergo health checks prior to release.

Fishers were held for 16.2 days on average (SE = 0.96) and during this time behavioural data were collected to quantify two different behavioural traits: docility and fearfulness. Docility, measured as the resistance to leave the transport box, was scored by a direct observer and using the video recording system monitoring the pens continuously. Fearfulness, measured by using a novel object test to score the interaction between fishers and two to three different unfamiliar objects, were recorded using only the video recording system to avoid the potential interference of the observer.

The docility was tested in 110 focal fishers, with a total of 198 tests measuring time to leave the nest box. The fearfulness trait was tested in 103 focal fishers, with a total of 255 tests performed over 3060 hours of video. Behaviours were assessed and the correlation between both traits were checked to describe potential behavioural patterns. In the future, combining this behaviour-based research with managing conservation strategies can enhance the success of reintroduction programs by selecting release candidates on the basis of behavioural patterns.



# Symposium Posters

Fisher (*Pekania pennanti*); ©Paul Jones



# Does slash pile retention alter diets and diet selection of meso-carnivores on managed timberlands?

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**Keywords:** *diet; prey availability; piled wood; industrial forest*

Large-scale anthropogenic disturbance related to commercial timber production can result in both fragmentation and loss of forests. One opportunity to potentially mitigate decreased forest connectivity and resources is through the aggregation of post-harvest woody debris from unused trees, stumps, and branches (ie, slash piles). Slash piles are often burned to increase area for new trees and to minimise wildfire risk. However, retained slash piles may serve as a proxy for large woody debris in areas with diminished forest structure. Despite the potential ecological relevance, the capacity at which small mammals and their predators utilise slash piles remains relatively unknown.

We summarised species interactions in areas with slash pile retention on private timberlands in coastal northern California, USA. We used remote camera data (n = 345 camera locations) and single species occupancy models to define space use for four meso-carnivores (Humboldt marten (*Martes caurina humboldtensis*), fisher (*Pekania pennanti*), gray fox (*Urocyon cinereoargenteus*), and bobcat (*Lynx rufus*). We also used remote camera data to create an index of small mammal prey relative abundance. We used detection dog team scat collection followed by DNA metabarcoding analyses to describe these mesocarnivores' diets (n = 25 scats,  $9.33 \pm 3.05$  species).

Preliminary data suggest similarities in prey occurrence and diet, but these patterns differed between species. We will assess preference with a use versus available framework and test whether these mesocarnivores selected prey that were more abundant and whether consumed species were disproportionately associated with piles. Our goal was to quantify whether and how slash piles influence both small mammal communities and carnivores' diet. If our study aligns with our predictions of increased use and prey selection, then slash piles may help conservation efforts, especially in areas lacking downed wood.



# Environmental and seasonal effects on activity pattern of pine marten (*Martes martes*)

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**Keywords:** *pine marten; activity; environmental factors; seasons; nocturnality*

Activity patterns of mammalian carnivores are amongst others influenced by environmental conditions, photoperiod, seasonality, reproductive behaviours and behavioral thermoregulation. I studied the effects of environmental variables and the influence of season and sex on pine marten (*Martes martes*) activity patterns in Norway and Sweden. To analyse activity patterns, I analysed accelerometer location data from three female pine martens instrumented with GPS telemetry collars from March 2021 through February 2022 in the Evenstadlia study area in southeastern Norway. I also analysed radio telemetry data from pine martens (n = 13) collected at Grimsö Wildlife Research Station in southcentral Sweden during 1987-1991.

Generalised linear mixed models for both data sets indicated that ambient air temperature, snow depth and daylight vs. darkness had significant effects on pine marten activity ( $p < 0.001$ ) whereas precipitation did not ( $p < 0.13$  and  $p < 0.69$  for Evenstad and Grimsö, respectively). Activity patterns did not differ significantly between sexes ( $p < 0.70$ ); however, activity patterns did vary between the seasons ( $p < 0.001$ ). Investigating nocturnality further, pine martens were significantly more active during nighttime across sexes and seasons. Pine martens were more nocturnally active during the fall/winter season than in spring/summer ( $p < 0.001$ ). Within seasons, males were more nocturnal than females during the spring/summer ( $p < 0.001$ ), while during the fall/ winter they were not ( $p < 0.56$ ).

The results highlight that seasonality and changes in temperature affect pine marten activity. In this study, pine martens' activity declined with decreasing temperatures. The much higher daytime activity levels in the summer could be related to increased activity during rearing of the young in the spring and mating season in the summer, whereas colder temperatures in fall/winter may force martens to conserve energy and seek thermal shelter due to their poorly insulative fur.

# Who's who? Distinguishing sympatric *Martes* species in camera trap images and a call for collaboration

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**Keywords:** *camera trapping; community science; data processing; Martes americana; Pekania pennanti*

Camera trapping is an increasingly common and important tool to achieve both research and management objectives<sup>[1]</sup>. Members of the marten guild have been the target of numerous camera trap projects due to their cryptic nature and difficulty to detect with other methods<sup>[2,3]</sup>. However, distinguishing similar looking species can be challenging, and although artificial intelligence tools are on the horizon, for the time being manual review and identification of camera trap images is the standard. Despite calls for increasing transparency and consistency in the reporting of camera trapping methods, there are no concrete guidelines in the literature for image review, leaving new researchers to 'fend for themselves' as they venture into identifying species present in their images<sup>[4]</sup>. Although each project will require its own unique image processing protocol depending on geographic location and goals, I would argue that the community of *Martes* researchers could benefit enormously from sharing our individual expertise.

My two-fold goal is to **1** provide a resource based on my personal image processing experience in North America and **2** solicit similar advice from other researchers with experience in other species, and curate a freely available web resource for future image taggers to use as they like. While camera trapping in three locations in the United States (California, Wisconsin, and Maine) I have reviewed 1.5 million trail camera images and compiled training protocols for volunteers. In these three distinct areas, the American marten (*Martes americana*) and the fisher (*Pekania pennanti*) live in varying degrees of sympatry, requiring careful processing of images to identify the correct species. By sharing my training protocols – which include reference images of marten and fisher detected at the same locations, day- and night-time photos, and summer and winter season detections – and providing a platform for others researchers to share images and guidelines for their target species, I hope to offer a useful resource to anyone in the *Martes* Working Group community who uses camera traps.

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# Detection dogs as a chance for pine marten (*Martes martes*) monitoring? Comparing the efficiency of a dog-team to human fieldworkers in finding scats

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**Keywords:** *pine marten; density estimate; non-invasive genetic sampling; scat-detection dog*

The European pine marten (*Martes martes*) is a forest-dwelling mustelid whose populations have declined throughout many parts of Europe mainly due to hunting and habitat loss. The species is therefore protected in many areas. In Southwestern Germany, hunting of the pine marten is still allowed, although there is little data on its distribution or population size. To better assess population status of the pine marten, our aim is to test monitoring methods to estimate population densities. We used a detection dog-team, consisting of the dog-handler and the dog, to search for pine marten scats and compared the findings to those of trained fieldworkers. The study was conducted in autumn 2021 in four forested areas (775 to 825 ha) in Southwestern Germany.

Scat surveys were organized on 500x500m sampling units. Each unit was surveyed once, in turn by either a fieldworker or the dog-team following a 1.75 km transect. From all collected scats, we determined the species using PCR-restriction fragment length polymorphism (PCR-RFLP). Only verified pine marten samples were genotyped with a set of 16 microsatellites and one sex marker. In total, 48 individual pine martens were determined (26 males, 20 females, 2 unknown). Out of these, the dog-team detected 37 (77%) with an almost balanced sex ratio of 1.25:1 (males:females) compared to the fieldworkers who detected 28 individuals (58%) with an unbalanced sex ratio of 1.7:1. The recapture rate of individual pine martens was higher for the dog-team (2.57; SE 2.33; range 1-12) than for the fieldworkers (1.47; SE 0.70; range 1-3). The genotyping results will be used to estimate pine marten densities with data collected by the dog-team only, the fieldworkers, and both methods combined. This allows us to compare the effectiveness of the methods and to further develop density estimation from scat searches.

# Forestry and environmental conditions as determinants of pine marten (*Martes martes*) occurrence in Norway

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**Keywords:** *clearcutting; forest specialist; Martes martes; multi-scale occupancy; Norway*

The pine marten *Martes martes* is a forest denizen often associated with late seral stage stands. Earlier research indicates that this species may be negatively impacted by modern forestry practices. However, the effects of current clearcutting methods upon pine marten occurrence in conjunction with changing environmental conditions are not well known.

In this study, we combined four years of countrywide data from a long-term camera trap (CT) survey in Norway. We used a multi-scale occupancy model to investigate how pine marten occurrence at multiple spatial scales is related to clearcuts and forests over 120 years old. We additionally tested how pine marten occurrence responded to factors such as habitat features and temporal changes in the environment (eg, snow depth and temperature). We found that pine martens occurred in most Norwegian landscapes, independent of the proportions of old forest and clearcuts. However, at the habitat patch scale, we found that pine marten occurrence was positively associated with the presence of old forest and terrain ruggedness, while there were no associations with (nearby) clearcuts. At CT sites near clearcuts, the detection probability (which we interpret as the intensity of use of CT sites) was negatively correlated with snow depth. In contrast, we found a positive association with snow depth at CT sites without clearcuts nearby. Furthermore, the intensity of use increased with temperature and the presence of boulders near a CT.

While old forest is important for pine martens, the current level and scale of clearcutting in Norway does not appear to be detrimental to the species' occurrence at the landscape level. Also, habitat features and structures facilitating subterranean and subnivean access may mitigate the lack of old forests attributes. Snow depth and temperature may also influence how much pine martens rely on old forests.

# Small mammal abundance as an index of Humboldt marten habitat suitability in proposed restoration areas

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**Keywords:** *habitat quality; Humboldt marten; prey availability; second growth forest; spatially explicit capture-recapture*

The Humboldt marten (*Martes caurina humboldtensis*) is a subspecies of Pacific marten that is of high conservation concern, with only a few hundred individuals estimated to remain throughout its historic range. One of the primary threats to their persistence is habitat loss and degradation from logging. In northern California, Redwood National and State Parks (RNSP) has plans to restore habitat through variable density thinning of selected stands. Our objective is to assess Humboldt marten habitat quality, through characterizing Humboldt marten prey populations in second growth forests and determining which habitat features they may utilise.

Humboldt martens predominantly prey upon small mammals such as Townsend's chipmunks (*Neotamias townsendii*), Humboldt flying squirrels (*Glaucomys oregonensis*), and Douglas squirrels (*Tamiasciurus douglasii*). These species are known to disperse seeds and spores, indicating healthy forest productivity, and their presence, abundances, and diversity may serve as indices of Humboldt marten habitat quality. In the summer of 2023, prey populations will be sampled using a combination of 10x10 Sherman and 4x8 Tomahawk live-trapping grids for eight consecutive trap nights. Spatial capture-recapture analysis will be used to estimate density and home range sizes of small mammal species in second growth stands in RNSP. In addition, we will evaluate how habitat elements such as shrub species and cover, woody debris, and tree species influence small mammal distribution and abundance.

Understanding the current state of small mammal populations, as well as the habitat features associated with key marten prey species, will help inform managers working towards restoring habitat for the Humboldt marten.



# Diel activity patterns and temporal overlap of mesocarnivores in response to drought-induced tree mortality in the Sierra Nevada mountains, California

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**Keywords:** *fisher; marten; activity patterns; tree mortality; California*

A recent massive tree mortality event in the southern Sierra Nevada mountains of California offered the context to explore the behavioral response of a diverse, native mammalian community to a rapid, broad-scale shift in habitat structure. We explored diel activity patterns using a long-term remote camera dataset collected by the Southern Sierra Carnivore Monitoring Program. First we described the diel activity patterns of fifteen native mammalian species in this region; then we assessed the plasticity of activity patterns by comparing each species' activity before (2013-14) and after (2018-19) the tree die-off event (2015-17). Finally, we explored whether changing activity patterns altered the potential for interactions between predator/prey or competitor species, and what implications this may hold for individual species coexisting on the landscape.

The southern Sierra is an important area to explore temporal activity patterns and plasticity because of its diverse carnivore community, which includes threatened (marten) and endangered species (fisher). Temporal niche partitioning may be particularly important for the promotion of stable co-existence in regions with high intra-guild diversity, such as occurs in this region. Of the fifteen species explored, only marten and fisher shifted their activity patterns significantly. Marten became more active during the day and less active at night, which led to an increased overlap with fisher. Fisher activity at dawn decreased significantly following tree mortality, but only on the Western Slope of the Sierra Nevada where the tree mortality occurred. In the high-elevation Kern Plateau to the east, which did not experience tree mortality, fisher activity remained bimodal with activity peaks just after dusk and dawn, coinciding with the activity peaks in fisher's small mammal prey (mice and squirrels). On the Western Slope, recent research has revealed that following tree mortality, fisher diet shifted away from small mammals towards the use of more fungi and fruits.

The damping of dawn activity on the Western Slope may be an indication that fisher are exhibiting temporal avoidance of their primary predators, bobcat and mountain lion, whose activity peaks at dawn, now that they are no longer hunting small mammals.

# Using temperature data loggers to monitor use of den boxes by fishers

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**Keywords:** *den boxes; habitat management; thermal dynamics; fishers*

Female fishers (*Pekania pennanti*) raise their kits in cavities within large-diameter trees. Large cavity-bearing trees are relatively scarce in managed forests and could be a limiting resource for fisher populations. Artificial den boxes may provide habitat for fishers where natural cavities are rare, but research focused on evaluating whether den boxes are a viable fisher habitat management tool requires accurate, cost-effective methods to monitor the use of den boxes by fishers.

Here, we describe a novel method for monitoring den boxes using internal den box temperature. We built and installed 80 fisher den boxes in northern Minnesota, USA, in fall 2019 and have monitored each den box year-round since installation using remote cameras and pairs of internal and external temperature loggers. We created a rule-based algorithm to identify when a fisher occupied a den box. Because the body heat of a fisher raises the internal temperature of a den box, the algorithm's rules were aimed at identifying periods when the internal temperature of a den box was warmer than predicted for an unoccupied box.

The algorithm successfully identified all instances in which remote cameras documented fishers using the den boxes, but did not identify uses by smaller mammals (eg, Sciurids). We suggest that temperature loggers can provide an accurate, sensitive, and cost-effective method for monitoring fisher den boxes.

# After the Gold Rush: impact of placer gold mining on Nähtra/Wolverine (*Gulo gulo*) in the Klondike Gold Fields, Yukon

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**Keywords:** *wolverine; density estimate; disturbance; trail camera; sound recorder*

Nähtra/wolverines are threatened by human disturbance across their circumpolar range. In central Yukon, Tr'ondëk Hwëch'in First Nation's (THFN) stewardship of the land and its inhabitants has been interrupted by industrial mining. Wolverines are bioculturally significant for THFN, who have identified mining as a threat to wolverines and other wildlife in their Traditional Territory. Academic research indicates that wolverines are affected by industrial activity, but little research has focused on mining.

In response to its high biodiversity and current changing landscape, Yukon South Beringia, which encompasses the THFN Traditional Territory, has been identified as a Priority Place. The Priority Place Initiative is a commitment to shift toward collaborative management that explicitly includes Indigenous Peoples and Traditional Knowledge. To meet this commitment, we are partnering to quantify the relationship between landscape condition and wolverine abundance and distribution.

We have deployed trail cameras and autonomous sound recording units (ARUs) across a gradient of disturbances. The trail cameras will photograph animals that pass by the cameras and the ARUs will record ambient sound. We will estimate wolverine abundance using camera data, quantify industrial activity using ARU data and aerial imagery, and evaluate the relationship between wolverine abundance and industrial activity. We expect that abundance will be lower in areas of higher disturbance. Our results will inform and support THFN's stewardship responsibilities, regional land use planning and environmental assessments, and inform wider conservation efforts for wolverine and other furbearers.

# Key insights of the diet of the pine marten (*Martes martes*) in the North of France using scats collected on nest boxes

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**Keywords:** *pine marten; scat; den box; diet; Limoniscus violaceus*

The Nord-Pas-de-Calais is the northern-most limit of the pine marten range in France. Before 2014, there existed no studies on the species there. After the redaction of a regional action plan on the pine marten in 2014, the use of artificial den boxes has been identified as a way to study the regional ecology of the species. Five of them have been installed in the biggest regional forest (Mormal) with camera traps to monitor the use by the martens, and two more in a protected area (Wood of Nostrimont).

When using artificial boxes, martens tend to lay scats on the roof. One of the boxes in Mormal has been used since its installation in 2018 and scats have been collected on its roof to study the local diet of martens. Manual and genetical analyses have been conducted and provide insights on the main prey eaten by the local martens. The results are consistent with other studies on the diet elsewhere in Europe. Differences exist between the two methods and only the manual dissection reveals the presence of a rare small mammal, the yellow-necked mouse *Apodemus flavicollis*. The genetic results allow us to discover the violet click beetle *Limoniscus violaceus*, a threatened insect. The genetic results are not strong enough yet to certify the identity, but if the sequence really belongs to *Limoniscus violaceus*, it will be the first record for the Nord-Pas-de-Calais. Further studies on the diet will be carried out when collecting scats in the Wood of Nostrimont.

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# Reintroduction of the pine marten (*Martes martes*) to the southwest of England

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**Keywords:** *reintroduction; pine marten; species recovery; translocation*

Pine martens were historically widespread and common in Britain but experienced an extensive decline and the population contracted to low numbers and limited areas by the early 1900s. Whilst legal protection has afforded some natural recovery in recent decades, this has been slow and active translocations have been used to aid the species' recovery.

Between 2019 and 2021, a collaborative effort between Gloucestershire Wildlife Trust, Forestry England, Forest Research and Vincent Wildlife Trust saw 35 pine martens translocated from the north of Scotland, where the population is doing well, to the Forest of Dean and lower Wye Valley, an area in the southwest of England that boasts a large area of suitable habitat and positive initial attitudes among stakeholders and the general public.

With the help of a large team of volunteers, monitoring is ongoing to keep track of the martens as the population expands and disperses into neighbouring regions and across the border into Wales. Engagement work also continues to raise awareness of pine martens among the public whilst working with landowners, foresters and other stakeholders to accommodate martens and improve habitat connectivity.



# Fragmented fishers — impacts of roads and tree mortality on occupancy dynamics of a native carnivore

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**Keywords:** *fisher; habitat use; natural disturbance; anthropogenic effects*

Fisher (*Pekania pennanti*) recolonised the state of Rhode Island, USA in the early 1980s. Since then, they have returned to much of the state despite steadily increasing human density and infrastructure development. Additionally, the forested landscape was decimated by gypsy moth (*Lymantria dispar dispar*) larval outbreak from 2015-2017 that resulted in defoliation and eventual death of trees in over 25% of the terrestrial land mass in Rhode Island.

The goal of this study was to assess how forest patch size and tree mortality affect habitat use of fisher. Seasonal (winter/summer) detection/non-detection data was collected from a state-wide camera trapping survey conducted from 2018-2022. In this analysis we calculated the size of the patch our cameras were located in where boundaries of patches were defined by surrounding roads. We fit dynamic occupancy models to investigate the effects of patch size and the tree mortality on site-level occurrence, colonisation, and extirpation.

We found fisher to be highly adaptable in this complex landscape, with high probability of occurrence at most sites and variability in their response to natural and anthropogenic disturbance. Our findings will aid the Rhode Island Department of Environmental Management in understanding factors that impact fisher distribution across Rhode Island in response to habitat patchiness caused by roads and natural disturbances.

# Developing a long-term strategic recovery plan for the pine marten (*Martes martes*) in Britain

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**Keywords:** *reintroduction; decision framework; habitat suitability; population viability*

In Britain, there is currently an increasing interest in reintroducing pine martens (*Martes martes*), but proposed projects are often locally planned and motivated without knowledge of other, similar projects or consideration of how they fit within the wider context of pine marten conservation. A national, strategic approach was needed to help guide decision makers.

The recovering population of pine martens in Scotland is currently the most suitable source of animals for translocations elsewhere in mainland Britain. However, there are still relatively few areas where pine martens have been established for a sufficiently long time and are at high enough densities to be able to sustain the removal of a limited number of animals for translocations. It is important to protect the recovering pine marten population in Scotland, as well as to facilitate natural recolonisation where possible. Therefore, reintroductions should only be done in a way that minimises risk to donor populations and maximises the probability of reintroduced populations establishing, spreading and ultimately linking up.

We developed a simple and transparent framework based on a combination of widely-used modelling methods that can be used to inform decisions around spatial targeting of pine marten conservation measures. We used habitat suitability modelling in combination with Circuitscape, to model connectivity across the landscape. We then carried out spatially explicit Population Viability Analyses (PVA) to link landscape structure from the habitat model with habitat quality and population dynamics. We ran a series of simulations to look at likely patterns of pine marten persistence, dispersal and range expansion both at a national scale with and without translocations, and, at a finer scale, to further investigate potential reintroduction regions.

The results were used to inform a series of recommendations for long term pine marten conservation in Britain.

# Identifying fisher conservation opportunities by evaluating movement patterns and connectivity in a dynamic landscape

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**Keywords:** *fisher; Pekania; habitat selection; movement ecology*

Understanding the space-use patterns of animals can inform management and conservation opportunities, especially in managed landscapes. We used fine-scale movement data to evaluate space-use patterns of fishers (*Pekania pennanti*) in a reintroduced population in the southern Cascade mountains of Oregon. We incorporated GPS-collar locations collected every 15-minutes during 21 GPS-collar deployments (n = 9 fishers, 2015 to 2018). We estimated fisher home ranges, evaluated movement paths within home ranges, parsing between corridor and non-corridor related travel, and estimated fine-scale space-use with step selection functions.

Fisher responses to patch structure and composition varied at different spatial scales. Home range areas were variable between sexes and among individual fishers, but male fishers generally exhibited larger use areas than females. Given limited sample sizes, we were not able to model fine-scale space-use patterns by sex (male vs. female) or seasons (reproductive vs. non-reproductive).

Corridors used by fishers exhibited more forest patches ( $\beta = 0.30$  [95% CI 0.17 - 0.45]), longer patches (0.70 [0.19 - 1.22]), and lower stream density (-1.28 [-2.20 - -0.36]) than non-corridors within their ranges. Corridors were weakly associated with smaller patch sizes (-0.57 [-1.39 - 0.25]) and less mean difference in tree height (-0.43 [-0.92 - 0.06]) than non-corridors. At a finer-scale, fishers selected for higher canopy cover (0.16 [0.09 - 0.23]), greater tree diameter diversity (0.21 [0.14 - 0.28]) and greater tree height (0.21 [0.09 - 0.33]). Identifying multi-scale space-use patterns in a mixed-ownership landscape allowed us to illustrate vegetation and patch characteristics that may promote and maintain connectivity for fishers.

# The influence of vole cycles, habitat parameters and environmental factors on pine marten population dynamics in south-eastern Norway

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**Keywords:** *clearcutting, forest specialist, Martes martes, multi-scale occupancy, Norway*

The pine marten *Martes martes* is a forest denizen often associated with late seral stage stands. Earlier research indicates that this species may be negatively impacted by modern forestry practices. However, the effects of current clearcutting methods upon pine marten occurrence in conjunction with changing environmental conditions are not well known. In this study, we combined four years of countrywide data from a long-term camera trap (CT) survey in Norway. We used a multi-scale occupancy model to investigate how pine marten occurrence at multiple spatial scales is related to clearcuts and forests over 120 years old. We additionally tested how pine marten occurrence responded to factors such as habitat features and temporal changes in the environment (e.g., snow depth and temperature). We found that pine martens occurred in most Norwegian landscapes, independent of the proportions of old forest and clearcuts. However, at the habitat patch scale, we found that pine marten occurrence was positively associated with the presence of old forest and terrain ruggedness, while there were no association with (nearby) clearcuts. At CT sites near clearcuts, the detection probability (which we interpret as the intensity of use of CT sites) was negatively correlated with snow depth. In contrast, we found a positive association with snow depth at CT sites without clearcuts nearby. Furthermore, the intensity of use increased with temperature and the presence of boulders near a CT. While old forest is important for pine martens, the current level and scale of clearcutting in Norway does not appear to be detrimental to the species' occurrence at the landscape level. Also, habitat features and structures facilitating subterranean and subnivean access may mitigate the lack of old forests attributes. Snow depth and temperature may also influence how much pine martens rely on old forests.

# Waswanipi Wapistan project: An indigenous tailored initiative for the American marten monitoring

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**Keywords:** *pine marten; scat; den box; diet; Limoniscus violaceus*

The Cree territory (Eeyou Istchee, Canada) has been subject to many perturbations in the last decades. Logging activities, mining, and road development have substantial impacts on the landscape and the Cree way of life. Indeed, forest rejuvenation and fragmentation of mature coniferous forest stands affect notably wildlife species that are of great importance to the tallymen and hunters. The Cree First Nation of Waswanipi (CFNW) wishes to monitor impacts of these perturbations on wildlife for sound management of the territory. In 2018, CFNW developed the Wapistan project: a long-term project focused on American marten (*Martes americana* or wapistan, in Cree) to develop a tailored method to monitor the environment and to become self-sufficient regarding it, as a community. The presence of wapistan is a good indicator of the health of its environment, as an umbrella specie in the boreal forest. The innovation here lies in the fact that we aimed at developing a tailored method, one which reconcile the scientific and traditional indigenous knowledge and involve the future of the community: its youth. In other words, a “Cree method”, that would have more meaning and significance for the community. It’s being done by involving biologists (western science), experienced tallymen (traditional knowledge) and young trainees. To achieve our goals, it was imperative to include an educational program in the development, to ensure the sustainability among CFNW members. Along the way, the CFNW developed great collaboration with different partners, including universities, and communicate results among the population. In addition to the initial objectives, the Wapistan project collaborators aim at explaining the population dynamics of the American marten. Thus, the combination of remote cameras being deployed and snowtracking allow to evaluate response of wapistan to habitat changes, interspecific interactions, and snow conditions on the territory of Waswanipi.