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Celebrating wildlife population recovery through education

Gioele Passoni,[1,2,4,*,@]
Tim Coulson,[1,4]
Francesca Cagnacci[2,3,4]
Supporting authors[5]

Large mammal populations are rapidly recovering across Europe, yet people have not readapted to living with wild animals, resulting in human–wildlife conflict. We believe that society should unite to make the most of the instances of nature recovery, and propose science and education as the key to success.

The societal challenges of nature recovery

Most people living in Europe grew up in naturally depleted and degraded ecosystems with little or no wildlife. However, in the past decades, a few large mammal populations have been recovering in some regions [1–3]. These increasing trends can contribute to achieving several biodiversity targets agreed in global treaties such as the United Nations' Sustainable Development Goals, the Kunming–Montreal Global Biodiversity Framework, and the Bern Convention. Nonetheless, we argue that large parts of society are not prepared to make the most of these ecological changes and must strive to learn to adapt. We take the example of the recovery of a large mammal community in a human-dominated Alpine region and discuss its causes and implications for people and wider society. Although we have focused on a relatively small region, this recovery has been observed throughout Europe [3].

The recovery of large mammals in the Alps

Most research showing detailed population trends in recovering European ecosystems has focused on single taxa. Here, we show the long-term trends of both the societal and ecosystem components at different trophic levels (Box 1). The study area, Trentino, Italy, covers 6207 km^2 in the Italian Eastern Alps (see Figure I in Box 1). Since 1921, the human population has grown by over 30% to over 500 000 people. Upward trends in urban areas at lower altitudes were paralleled by overall depopulation in rural areas at higher elevations, except for sporadic rebounds caused by a phenomenon termed 'new highlanders' (Box 1) (G. Passoni, PhD thesis, University of Oxford, 2022).

Rural depopulation caused agricultural land to shrink and become abandoned [4,5]. As a result, forest cover doubled (Box 1) and offered habitat and shelter for large mammals (G. Passoni, PhD thesis, University of Oxford, 2022) [6]. The rise in ungulate populations, such as roe deer (*Caprelous capreolus*), red deer (*Cervus elaphus*), chamois (*Rupicapra rupicapra*), wild boar (*Sus scrofa*), and mouflon (*Ovis aries*), which occurred since the 1970s (Box 1), provided prey for the wolf (*Canis lupus*), which naturally recolonised Trentino in 2010 and has expanded, with 26 packs recorded in 2021[i,ii]. Finally, brown bears (*Ursus arctos*) were reintroduced in 1999; their population is growing and it is currently estimated at 78 individuals excluding cubs[ii].

The ecosystem in Trentino is still highly dynamic, and the effects of emerging ecological processes stemming from species' interactions are yet to be fully detected (G. Passoni, PhD thesis, University of Oxford, 2022). For example, we expect herbivores to impact forest regeneration and habitat structure, and predators to affect prey health and population dynamics [7–9]. Future changes are likely to include knockon effects on biodiversity and the wider ecosystem, and could potentially contribute towards the targets of the EU biodiversity strategy for 2030 and the Nature Restoration Law.

Nature and society change at different speeds

The recovery of forests and large mammal populations described earlier was mainly caused by socioeconomic changes [5]. Substantial habitat recovery caused by land abandonment has been observed elsewhere across Europe and was previously referred to as 'passive rewilding' [3]. Here, we support the view that, when given the chance in less disturbed habitats, wildlife may recover quickly from low population densities or even local extirpation [1,2] (G. Passoni, PhD thesis, University of Oxford, 2022). However, we also highlight that the recovery in Trentino was crucially supported by effective environmental legislation, such as the EU's Habitats and Birds Directives, and proactive management practices, such as the reintroduction of some species and selective hunting [1]. Without conservation efforts, the recovery of wildlife would probably have not occurred to this extent, especially for carnivores [1].

Following the decline in large mammal species in the past few centuries, many European societies have largely forgotten how to live with nature and wild animals. The decline caused a shifting baseline syndrome, whereby a world without wildlife was considered to be the norm and people have become increasingly detached from nature [10]. In addition, modern communication media have spurred new forms of polarised anthropomorphisation of animals. For example, the heritage of the 'bad wolf' image typical of fairy tales lurks in social media posts arguing against the conservation of wolves. At the same time, a major cycling event in Italy used a smiley wolf cartoon ('Wolfie') as its mascot, and individual bears are given human names inspired by novels and movies. Given the relative rapidity of the wildlife's recovery, society has not yet learnt how to adapt to living with wild animals, and conflict is emerging [1,2]. In the past decade, people and wildlife have increasingly competed for resources (e.g.,

depredation of livestock by wolves, deer causing damage to crops and forest) and space – as mass tourism and outdoor activities have surged (Box 1). Farmers have been reluctant to accept the costs of wildlife damage despite preventive and compensatory policy measures (e.g., electric fences, guard dogs, and financial compensation).

Further, media coverage and local debate suggest that most people are not correctly informed about or willing to embrace the hazards related to wild animals. A hike in Trentino had virtually no wildlife-related risks 20 years ago. In the past 10 years, Trentino recorded seven harmful bear attacks on humans, one of which, in April 2023, was lethal[iii]. While this is a significant increase, many more people die and are injured as a result of avalanches each year[iv].

Society has been slower at re-adapting to wildlife than wildlife has been at adapting to human-dominated landscapes. The resulting conflict can significantly change human perceptions of species. For example, public acceptance of bears decreased from 70% before their reintroduction to 30% after reintroduction 14 years later [11]. We believe that such fluctuations in public perceptions occur because people are not sufficiently aware of and educated about the implications of living with wild animals. A few serious but statistically rare events such as a bear attack can disproportionately affect public opinion, further exacerbating conflict and rapidly reducing the acceptance of wildlife [11]. Thus, an uneducated population lacking ecological knowledge is more exposed to wildlife's damage and risks, but is also more

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Box 1. Ecosystem and population trends in Trentino

Since the beginning of the 20th century, Trentino (Figure I) saw large changes in the human population, forest cover, and several populations of large mammals.

- The human population has increased by 34% since 1921 (Figure IIA–B). This growth has mainly occurred below 600 m (Figure IIA), where the population increased by 66%. Above 600 m (Figure IIB), the population decreased by 9% overall and by 18% between 1921 and 1991[x].
- Forest cover doubled from ~180 000 ha in 1936 to ~359 000 ha in 2015 (Figure IIC) [6].
- Red deer (*Cervus elaphus*) expanded across the study area and increased from two individuals reported to have been shot by hunters in 1971 to 2557 in 2020 (Figure IIE)[i]
- Chamois (*Rupicapra rupicapra*) have increased fivefold since 1971 (Figure IIF)[i].
- Roe deer (*Capreolus capreolus*) also increased by 128% since 1971, although their increase was not linear (Figure IID)[i].
- Populations of mouflon (*Ovis aries*) and wild boar (*Sus scrofa*) have both increased significantly as a result of both legal and illegal introductions (Figure IIG–H)[i].
- The brown bear (*Ursus arctos*) population consisted of three males in 1999, when ten individuals were reintroduced. In 2021, the population was estimated at 78 individuals, excluding the cubs (Figure IIK)[ii].
- Wolves (*Canis lupus*) naturally recolonised Trentino, with the first pack emerging in 2013, and constantly expanded across the region, with up to 26 packs and 178 individuals in 2021 (Figure IIJ)[ii].
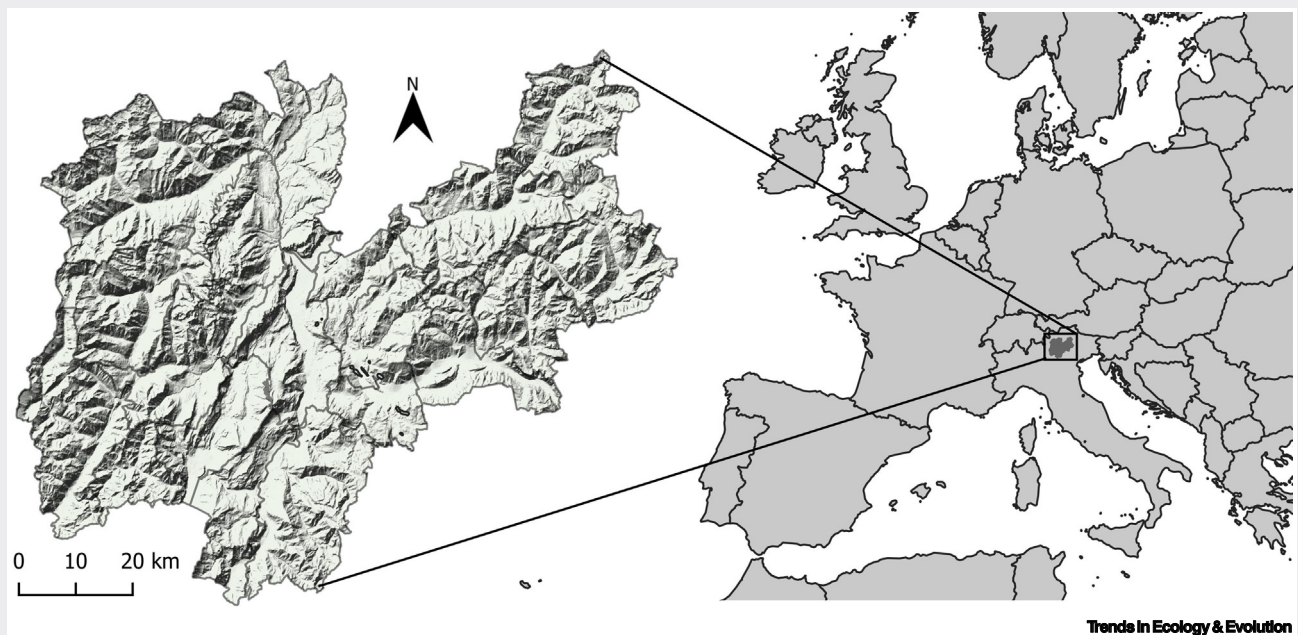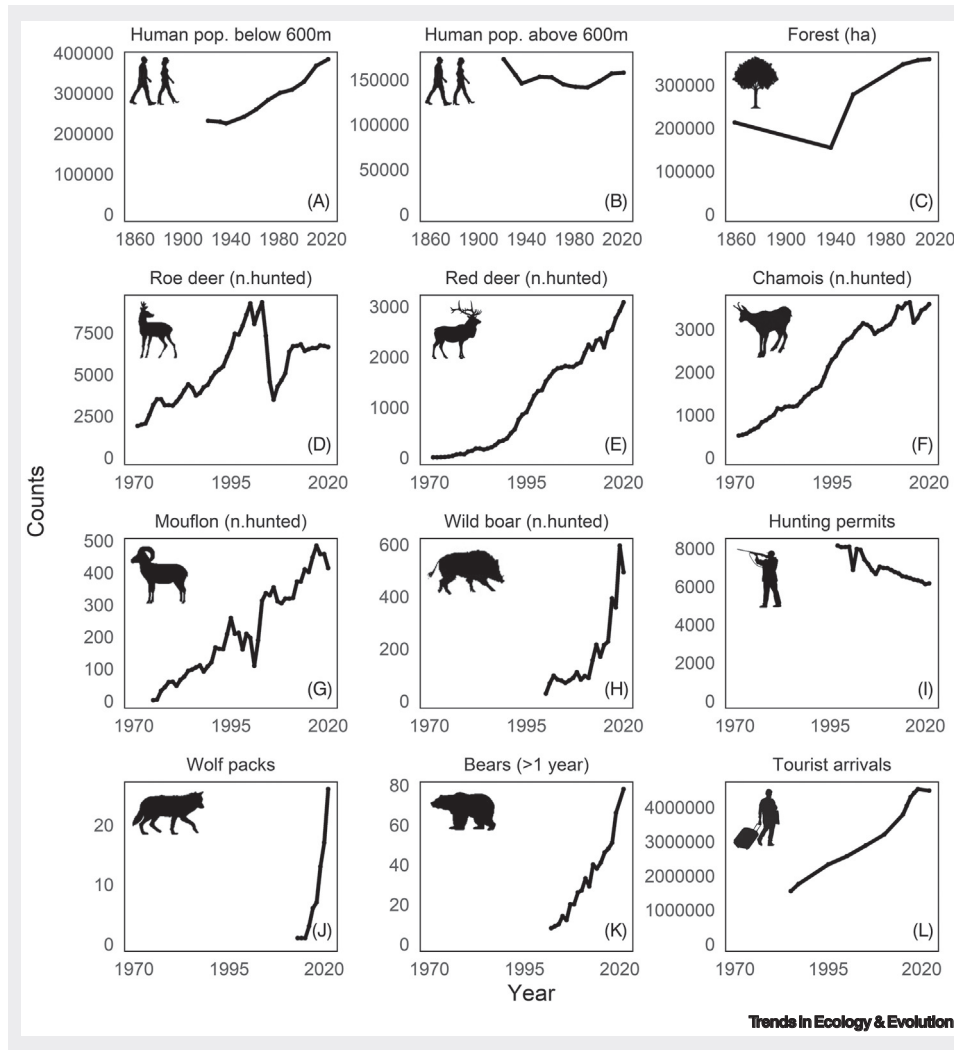

Figure I. Map of Trentino, Italy.

Figure II. Human and wildlife population trends in Trentino. Trends in (A,B) the human population; (C) forest cover (ha); (D–H) ungulate populations, showing the number of hunted individuals of (D) roe deer (*Capreolus capreolus*), (E) red deer (*Cervus elaphus*), (F) chamois (*Rupicapra rupicapra*), (G) mouflon (*Ovis aries*), and (H) wild boar (*Sus scrofa*); (I) hunting permits released; (J) the wolf population (*Canis lupus*), showing the number of wolf packs; (K) the bear population (*Ursus arctos*), showing individuals over 1 year of age; and (L) tourist arrivals in Trentino. Note that the *x*-axes from A–C start from 1860, whereas those for D–L start from 1970.

Education is the key towards sustainable coexistence

In the past century, our relationship with nature has changed profoundly. To tackle the unprecedented environmental challenges and reach our climate and biodiversity targets, we must become better and faster at understanding, handling and embracing positive ecological change. We believe that the key to success lies in science and education, and in how evidence-based knowledge is transferred throughout society. Indeed, education and awareness are at the core of the Kunming–Montreal Global Biodiversity Framework (Target 21).

Extensive education campaigns must be based on evidence, continuous monitoring, and effective communication strategies, informing the public on the problems and opportunities of living with wild animals. We must teach people about the hazards, the actions necessary to minimise risks, and the behaviour to follow in specific situations. These can include precautionary driving to avoid car accidents, fences to protect agriculture and forestry from deer browsing, or conduct in case of a bear encounter. School children from both urban and rural settings should be taken out and taught about living with wildlife in a similar manner to how they are taught to safely cross a road or ride a bike. People also need to be warned about the risks specific to an area using conventional methods, such as signs, or by providing up-to-date information about animal distribution based on biologging, field monitoring, and citizen science. Similar warning systems already

The text before "Education is the key" section reads:

susceptible to misinformation and political speculations.

exist for the weather, fires, avalanches, and even midges[v].

Local communities must be taught about the positives of wildlife and celebrate nature's recovery as an opportunity. A complex wildlife community provides key ecosystem services, such as seed dispersal, energy and nutrient cycling, prevention of overbrowsing, and habitat regeneration, ultimately benefitting human mental health and wellbeing [7–9,12]. The annual value of the global wildlife tourism market was recently estimated at over US $150 billion and is expected to grow over the next decade[vi]. Public funding and private investments should support a more aware and educational form of tourism, such as sustainable wildlife watching, environmental volunteering, and farm stays where visitors can appreciate the challenges faced by local communities. Education campaigns must also acknowledge that to ensure wildlife's persistence and peaceful coexistence in human-dominated environments, animal populations may require active management strategies including some forms of population control. Some education campaigns have already been carried out in the Alps[vii] and the popularity of socially and wildlife-friendly initiatives is growing. For example, 'Progetto Pasturs'[viii] trains volunteers to share their time and knowledge with shepherds and help them prevent depredation by large carnivores. In Central Italy, 'Rewildling Appennines'[ix] organises experiences where people can participate in wildlife-watching excursions, meetings with local food producers, and workshops on ecology and rewilding.

Nevertheless, awareness and education alone may not always translate into favourable actions and behaviours towards wildlife. It is therefore equally important that policymakers and administrators appreciate the importance of wild animals and are held accountable for their responsibility to safeguard them. Illegal activities that harm animals and their populations must be discouraged and prosecuted. Wildlife needs to be considered as a valuable resource – as opposed to a nuisance – and must become a priority in political discourse.

The recovery of large mammal populations in Europe is a positive story for conservation. However, if we want to peacefully live alongside wildlife, we must unite our efforts across all sectors of society, from national policy to local administration, from nongovernmental organisations (NGOs) to private enterprises, and from farmers to scientists. All parties must overcome conflict and start a constructive conversation to share data, opinions, and best practices to come up with joint solutions. This article is an initial outcome of such an attempt, including authors from universities, research institutes, the local administration, a hunting association, and a national park authority.

Declaration of interests

The authors have no interests to declare.

Resources

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[ii]https://grandicarnivori.provincia.tn.it/Large-Carnivores-Report/Large-Carnivores-Report-2021
[iii]www.theguardian.com/world/2023/apr/07/bear-kills-jogger-on-woodland-path-in-northern-italy
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[vi]www.researchandmarkets.com/reports/5734416/
[vii]https://dinalpbear.eu/project/about-the-project/
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[1]Department of Biology, University of Oxford, 11a Mansfield Rd, Oxford OX1 3SZ, United Kingdom
[2]Animal Ecology Unit, Research and Innovation Centre, Fondazione Edmund Mach, Via Edmund Mach 1, 38098 San Michele all'Adige, Trento, Italy
[3]NBFC, National Biodiversity Future Center, Palermo 90133, Italy
[4]These authors contributed equally
[5]The supporting authors are: Luca Pedrotti, Stelvio National Park, Via De Simoni 42, 23032 Bormio, Sondrio, Italy; Federico Ossi, Animal Ecology Unit, Research and Innovation Centre, Fondazione Edmund Mach, Via Edmund Mach 1, 38098 San Michele all'Adige, Trento, Italy and NBFC, National Biodiversity Future Center, Palermo 90133, Italy; Andrea Corradini, Animal Ecology Unit, Research and Innovation Centre, Fondazione Edmund Mach, Via Edmund Mach 1, 38098 San Michele all'Adige, Trento, Italy and NBFC, National Biodiversity Future Center, Palermo 90133, Italy; Charlotte Vanderlocht, Animal Ecology Unit, Research and Innovation Centre, Fondazione Edmund Mach, Via Edmund Mach 1, 38098 San Michele all'Adige, Trento, Italy; Nicola La Porta, EFI Project Centre on Mountain Forests (MOUNTFOR), Trento, Italy and Department of Civil, Environmental, and Mechanical Engineering (DICAM), University of Trento, via Mesiano 77, 38123 Trento, Italy; Stefano Gobbi, Department of Civil, Environmental, and Mechanical Engineering (DICAM), University of Trento, via Mesiano 77, 38123 Trento, Italy and Department of Civil, Environmental and Mechanical Engineering (DICAM), University of Trento, via Mesiano 77, 38123 Trento, TN, Italy; Marco Ciolli, Department of Civil, Environmental and Mechanical Engineering (DICAM), University of Trento, via Mesiano 77, 38123 Trento, TN, Italy; Natalia Bragalanti, Servizio Faunistico, Provincia Autonoma di Trento, Via GB Trener 3, 38121 Trento, Italy; Gabriella Rivaben, Servizio Faunistico, Provincia Autonoma di Trento, Via GB Trener 3, 38121 Trento, Italy; Mariasanta Calabrese, Servizio Faunistico, Provincia Autonoma di Trento, Via GB Trener 3, 38121 Trento, Italy; Claudio Groff, Servizio Faunistico, Provincia Autonoma di Trento, Via GB Trener 3, 38121 Trento, Italy; Enrico Ferraro, Associazione Cacciatori Trentini, Via Guardini 41, 38121 Trento, Italy; Alessandro Brugnoli, Servizio Faunistico, Provincia Autonoma di Trento, Via GB Trener 3, 38121 Trento, Italy.

*Correspondence:
passonigioele@live.it (G. Passoni).
@Twitter: @GI0ELE

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