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Review Article

Navigating challenges and opportunities in predator rewilding: Perspectives from the recolonization of Eurasian Otters (*Lutra lutra*) in Norway

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ABSTRACT

Rewilding predatory species has the potential to induce intricate trophic cascades and elicit multifaceted outcomes at biological and societal levels. The primary goal of rewilding is to restore ecological functionality and elevate species populations. However, the ecological interactions and socio-economic conflicts that emerge from rewilding are often underexplored in the literature. Natural recolonization of Eurasian otters (*Lutra lutra*) in Norway is presented as a paradigmatic example of historic and novel conflicts and interactions across ecological and socio-economic domains that ensue after predator recovery. Expanding otter populations in Norway have already led to increased incidences of human-wildlife conflicts because of predation on endangered Atlantic salmon (*Salmo salar*) and seabird species, sometimes leading to the persecution of otters. The resulting tensions have created polarized views among conservation advocates and other stakeholder groups, including anglers, local river management organizations, eiderdown harvesters, and the aquaculture industry. Emblematic of many challenges confronted by practitioners of rewilding and restoration, we use the Norwegian case study to propose adaptive management strategies to mitigate these conflicts and promote coexistence, such as humane removal or translocation of otters, use of repellents or exclusion structures, habitat restoration, and compensation payments for losses. We also highlight knowledge gaps and emerging challenges to direct future research for conflict mitigation. Our findings can guide predator rewilding

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schemes more broadly; although focused on otters in Norway, this perspective offers general learning points and strategies for evidence-based management of predator recovery and human-wildlife interactions globally.

1. Introduction

Biodiversity conservation efforts seek to halt and reverse species declines through actions that target both the biological mechanisms underpinning species' biology (Carver et al., 2021; Bakker et al., 2018; Soule and Noss, 1998) and societal factors that contribute to pro-environmental sentiment and behaviour (Manfredo et al., 2016; Schultz and Zelezny, 2003). Rewilding has become a central strategy within the UN Decade on Restoration, which prioritizes habitat restoration and species recovery to address environmental and societal challenges (Jepson, 2022). For the purposes of this paper, we adopt the definition proposed by Prior and Brady (2017), who describe rewilding as "*the process of (re)introducing or restoring wild organisms and/or ecological processes to ecosystems where such organisms and processes are either missing or are 'dysfunctional'*" While human intervention may be required at the outset, the aim of rewilding is to support the recovery of self-sustaining ecosystems and mitigate the negative impacts of the anthropogenic activities that caused ecosystem decline (Svenning et al., 2024). Many rewilding programs specifically focus on iconic "umbrella species", such as larger predatory species (Caro, 2010; Lõhmus et al., 2017; Noble et al., 2020, Svenning et al., 2016). However, outcomes of the rewilding of predators can be complex and multifaceted (Egoh et al., 2021, Svenning et al., 2016).

Rewilding of predatory species is an example of a wicked problem (Rittel and Webber, 1973), with complexity and both ecological and social consequences (Svenning et al., 2016; Drenthen. 2018). Ecologically, the rewilding of mammalian predators can trigger cascading effects through top-down regulation of food webs (Ripple et al., 2014; Hardalau et al., 2024). A classic example is the rewilding of extirpated grey wolves (*Canis lupus*) in Yellowstone National Park, which triggered complex responses among both plant and herbivore species (Ripple et al., 2025; Ripple and Beschta, 2012), though hunting outside the park boundaries also contributed to ungulate population control, potentially influencing the observed trophic cascades (Hardalau et al., 2025). However, ecological outcomes alone do not determine the viability of rewilding efforts. Social dimensions are equally important, yet often more contentious. Rewilding can provoke negative sentiment and controversy, as it involves multiple stakeholders, each bringing different values, priorities, and goals, which can complicate decision-making and implementation of such conservation efforts (Bauer et al., 2009; Butler et al., 2021; Perino et al., 2019). Indeed, conservation outcomes can be linked to the degree of societal acceptance of human-wildlife coexistence, reflecting the interplay between ecological goals and socio-cultural realities (Manfredo et al., 2021; Tanguay et al., 2021; Farwig et al., 2025; Metcalf et al., 2025). While the concept of coexistence is debated and context-dependent (Fiasco and Massarella, 2022), we define it here following Carter and Linnell (2016) and Pooley et al. (2021) as the acceptable sharing of landscapes between the focal species and relevant stakeholder groups, where both persist with tolerable levels of conflict. Coexistence of wildlife and humans can be challenging to achieve. For example, the expansion of grey wolves in Norway and Denmark has sparked conflict over livestock predation and heightened urban–rural divides in national conservation politics (Højberg et al., 2016; Krange et al., 2017, 2022; Skogen et al., 2008), resulting in restricted wolf populations confined to designated zones and subject to culling outside these areas; an outcome that illustrates the challenges of coexistence in practice.

The rewilding of predatory species presents challenges and opportunities for biodiversity conservation, influencing natural ecosystems and human societies. The recolonization of the Eurasian otter (*Lutra lutra*) in Norway serves as a case study to illustrate practical considerations for evidence-based and adaptive management strategies that can encourage coexistence across the species' range. This paper draws from the Norwegian experience to explore the complexities of predator rewilding and provide examples of both passive and active rewilding globally. The focus of the case study offers a specific perspective, and we acknowledge how cultural and social positionality can influence attitudes and outcomes. Drawing on lessons from otter recolonization in Norway, the paper concludes with considerations for predator rewilding initiatives across ecological and socio-economic domains, management strategies, and future research priorities.

2. A background on rewilding

The concept of rewilding originated within the fields of biology and conservation during the 19th century and was later formalized by conservationist Dave Foreman in the 1990s (Soule and Noss, 1998). It is a term that has developed since its origins, and following from the definition proposed by Prior and Brady (2017), it now encompasses the restoration of ecological processes through passive protection of remnant populations, all the way up to large-scale translocation of species to landscapes in which they were extinct. The primary objective of rewilding, also known as "wilderness recovery", is to restore populations, ecosystem processes, or landscapes to better conditions, focusing on the restoration of ecological functions, where ecosystems can self-regulate and support biodiversity, ultimately increasing resilience to stressors (Foreman, 2004, Jørgensen, 2015, Carver et al., 2021). After initial human intervention, the process of rewilding operates on long temporal scales, as the ecosystem recovers through succession and species dispersal (Speed et al., 2019). The conceptual basis of rewilding is grounded in trophic interactions, wherein a single species can exert multiple influences across an ecosystem and across multiple levels within a food web. For example, predators can be significant forces of selection on prey populations by removing sick, weak, or otherwise disadvantageous individuals from a population. Predation may therefore slow the spread of pathogens (Krumm et al., 2010), remove animals at senescence that compete for space and food with mature individuals (Slobodkin, 1968), drive selection that increases the fitness of animals in the population (Abrams, 2000), and impede the establishment of invasive species (Tuckett et al., 2021). As such, top-down control through trophic cascades is often among the intended outcomes of predator rewilding. Although rewilding stems from the term "wilderness recovery", it does not always occur in pristine wilderness; it increasingly takes place in landscapes that have been heavily modified by human activity. These anthropogenic environments introduce novel ecological dynamics and management challenges, as species adapt to conditions shaped by urbanization and infrastructure. For example, smooth-coated otters (*Lutrogale perspicillata*) have successfully established populations in Singapore's urban waterways, facilitated by adaptive management strategies, illustrating how predator recovery can unfold in highly altered ecosystems (Khoo and Lee, 2020).

Rewilding encompasses a range of strategies that varying degree of human intervention. To capture this variation, we distinguish between two broad categories: passive rewilding and active rewilding (Araújo and Alagador, 2024), highlighting some ecological and social implications of predator recovery (Fig. 1, Table 1). ***Passive rewilding*** relies on reducing human pressures to allow natural

Fig. 1. Corresponding examples from Table 1 of carnivore species involved in rewilding efforts, highlighting both passive and active strategies. (A) Grey Wolf (*Canis lupus*); (B) Sea Otter (*Enhydra lutris*); (C) Iberian Lynx (*Lynx pardinus*); (D) Eurasian Lynx (*Lynx lynx*); (E) Brown Bear (*Ursus arctos*); (F) African Wild Dog (*Lycaon pictus*); (G) Jaguar (*Panthera onca*); (H) Tiger (*Panthera tigris*). All pictures are stock images licensed from Canva Pro.

recovery. Common measures include species protection through legal designations (Mollett et al., 2025), habitat protection (Hilty et al., 2024), and hunting moratoria (Perino et al., 2019). The objective of passive rewilding is to facilitate the natural immigration and/or the increase of target species abundance by reducing human interference (Corlett, 2016; Pereira and Navarro et al., 2015; Araújo and Alagador, 2024). *Active rewilding,* by contrast, involves deliberate supplementary releases or reintroductions of individuals through translocations from other wild areas (e.g., MacPherson and Wright, 2021) or captive breeding programs (e.g., Lamb et al., 2024).

In this perspective, the focus is on the rewilding of predators, a process that can reshape ecosystems and provoke societal responses, often leading to new challenges and conflicts. Though passive rewilding is often linked with the natural regeneration of plant communities (e.g., Jiménez-Franco et al., 2024; Morel et al., 2020), it is also applicable to mammalian predators. For example, in Slovakia, passive rewilding was used to increase population sizes of multiple large carnivores by introducing a hunting moratorium on grey wolf, Eurasian lynx (*Lynx lynx*), and brown bear (*Ursus arctos*) after decades of hunting resulted in declines (Rigg et al., 2011; Table 1). Subsequently, the increased carnivore populations led to more predation on livestock and ungulates, which sparked socio-economic conflicts with farmers and hunters (Rigg et al., 2011; Smolko et al., 2025). In India, reducing human activity in a national park enabled a tiger (*Panthera tigris*) population to recover, resulting in ecological and societal consequences when leopards (*Panthera pardus*) shifted their distribution towards areas with more human settlements, leading to increased livestock depredation and potential human-wildlife conflicts (Harihar et al., 2011). Rewilding of large carnivores, while ecologically beneficial, can be particularly contentious in regions where predator ranges overlap with human activity, which has led to direct attacks on people, such as increased bear incidents following protection measures (Bombieri et al., 2019), fatal tiger attacks in central India (Dhanwatey et al., 2013), and broader concerns about human safety in rewilding contexts (Bombieri et al., 2023).

In South Africa, an active rewilding initiative to boost the local population and restore ecosystem processes included the translocation of African wild dogs (*Lycaon pictus*) into Hluhluwe-iMfolozi Park (Gusset et al., 2008). While tourists expressed positive sentiments about the opportunity to see wild dogs, local Zulu villagers, who experienced livestock losses, held negative views of the rewilding initiative (Gusset et al., 2008). Similarly, in another active rewilding effort involving smaller (400 km^2) protected areas in South Africa, African wild dogs preferred hunting for two ungulate species, suggesting a specialized niche. However, this did not lead to a trophic cascade through adversely affecting prey population sizes (Vogel et al., 2018). In Alaska, sea otters (*Enhydra lutris*), previously exterminated by the fur trade, were reintroduced through the translocation of 60 individuals in the late 1960s, leading to both ecological and social ramifications. This active rewilding led to a significant increase in sea otter numbers, which, in turn, brought sea cucumber (*Parastichopus californicus*) populations to near extinction, creating conflicts with the commercial fishing industry (Larson et al., 2013). Ultimately, predator rewilding initiatives illustrate the delicate balance between ecological recovery and human interests, with outcomes ranging from significant to subtle ecosystem transformations and varying impacts on local stakeholders. To explore these dynamics in greater depth, we examine the case of otter rewilding in Norway.

3. The case of otters in Norway

Otters are semi-aquatic mammals living in lakes, rivers, and oceans, distributed from the high Arctic of Norway to the tropical rainforests of the Amazon (Kruuk, 2006). The Eurasian otter (hereafter otter) is distributed throughout Europe and parts of Asia and northern Africa. Otters are top predators leading to cascading trophic effects (Gallardo et al., 2024) and are often viewed by humans as intruders or competitors (Berg, 2025). They are vulnerable to human impacts including pollution of waterways, biomagnification of toxins in their food, loss of habitat, bycatch in fisheries, road-kills, migration barriers, illegal trade of their fur, and persecution instigated by human-wildlife conflicts (Duplaix and Savage, 2022; Van Dijk et al., 2021; Box 1).

Otters were historically prevalent across Norway. However, competition with humans for fish led to government-sanctioned culling using paid bounties between 1900 and 1932, significantly reducing their populations (Christensen, 1995). Although the practice of paying bounties ceased, hunting continued, further exacerbating the population decline until the 1980s (Heggberget, 1996). A moratorium on hunting came in place in 1982 and was enacted following Norway's adoption of the Bern Convention and the European Habitat Directive. This regulatory shift marked the commencement of passive rewilding for otters in Norway, although the population has yet to fully recover in the southern regions (Fig. 2, Fig. 3). Additionally, otters have indirectly benefited from several conservation measures originally aimed at other species or objectives. For instance, liming acidified watersheds has boosted prey densities in affected systems (Hesthagen et al., 2011). Restrictions on Atlantic salmon (*Salmo salar*) commercial marine fisheries (Forskrift om fiske etter anadrome laksefisk i sjøen § 4, 2021) are expected to increase spawning stocks, thereby improving prey availability for otters. Modifications to lobster fishing regulations have reduced otter bycatch, although further restrictions on gill and fyke nets would enhance this effect (Landa and Guidos, 2020). Eradication programs targeting invasive American mink (*Neovison vison*), a competitor for prey, may also contribute to otter population growth (Stien et al., 2011).

These combined efforts have been successful, resulting in the redesignation of otters from Near Threatened to Least Concern on the Norwegian Red List in 2021. Population numbers have increased significantly (Van Dijk et al., 2021), allowing otters to recolonize much of their historical range, with robust population growth observed up to recent times (Fig. 2, Fig. 3). However, otters have returned to socio-ecological systems that have undergone significant change, with declining prey populations and the emergence of new industries. This shift has led to new challenges for management, manifesting both ecological implications and socio-economic conflicts.

Table 1
Examples of passive and active rewilding of mammalian predators, with ecological interactions and socio-economic conflicts.

Predatory Species	Rewilding Type	Context	Ecological interaction	Socio-economic conflict	Reference
Sea Otters (*Enhydra lutris)*	Active reintroduction	Reintroduction of sea otters in Alaska led to collapse of commercially important sea cucumber (*Parastichopus californicus*) fishery	Sea otters driving sea cucumber populations to severely low numbers	Sea cucumbers are depleted below sustainable fishery levels, causing conflict with fisheries and substance resource users	Larson et al. (2013)
Iberian Lynx (*Lynx pardinus)*	Active reintroduction	Reintroduction of lynx in Spain and Portugal	Trophic cascade initiated by reductions in mesopredators; red fox (*Vulpes vulpes*) and Egyptian mongoose (*Herpestes ichneumon*). Followed by increases in small game; European rabbits (*Oryctolagus cuniculus*) and red-legged partridges (*Alectoris rufa*).	Reintroductions were generally supported by the public, slightly less by hunters. Sentiments did not change post reintroduction.	Sarmento et al. (2021); Jiménez et al. (2019)
Eurasian lynx (*Lynx lynx)*	Active reintroduction	Reintroduction of lynx into the Swiss Alps and Jura mountains between France and Switzerland	Roe deer (*Capreolus capreolus*) abundance was higher in areas experiencing more livestock predation, indicating that elevated roe deer densities may increase encounter rates between lynx and livestock	Increased predation on livestock	Stahl et al. (2001)
Brown bear (*Ursus arctos)*	Active reintroduction	Release of bears into Italian Alps and Pyrenees	Bears have been found to facilitate long-distance dispersal of seeds from 47 diverse taxa, playing a distinct and complementary role in the ecosystem's seed dispersal mechanisms compared to other species.	Conflicts arose from livestock damage caused by bears (e.g., beehives, sheep), leading to the initiation of compensation funds. One human attack was reported, and three bears were translocated due to conflict.	Tosi et al. (2015); Lalleroni et al. (2017)
African wild dog (*Lycaon pictus)*	Active reintroduction	Reintroductions and translocations into different parks and enclosed areas in South Africa	Narrow dietary niche mostly consisting of impala (*Aepyceros melampus*) and nyala (*Tragelaphus angasii*), but no evidence of prey populations adversely declining	Tourists had positive perceptions of reintroductions, while Zulu villagers had negative views and increased misconceptions about risk of livestock losses	Gusset et al. (2008) Vogel et al. (2018)
Jaguars (*Panthera onca)*	Active reintroduction	Reintroduction of jaguars in Ibera national park in Patagonia, Argentina	Jaguars preying on capybaras (*Hydrochoerus hydrochaeris*) are expected to impact plant species composition and vegetation structure, potentially affecting threatened grassland birds, nutrient cycling, carbon sequestration, and fire regimes.	Old conflict between farmers and jaguars due to predation of sheep expected to resurface	Donadio et al. (2022) Avila et al. (2025)
Tiger *(Panthera tigris)*	Passive recolonization	Tiger populations were declining, but upon reduction of anthropogenic activity in a protected area in India, populations increased	Tiger presence shifted the diet and distribution of jaguars	More conflict with farmers due to increased predation on livestock	Harihar et al. (2011)
Grey Wolf (*Canis lupus)*	Passive recolonization	Legal protection and habitat recovery lead to increased wolf populations in Wisconsin between 1976 and 2000	Recolonizing wolves trigger trophic effects on understorey plant communities via predation on white-tailed deer (*Odocoileus virginianus*)	Depredation of livestock, hunting-dogs and road kills	Treves et al. (2002) Callan et al. (2013)

Box 1

Ecological interaction: Otters regularly prey upon adult Atlantic salmon in Norwegian rivers. A meal normally consists of approximately 1 kg fish (Carss et al. 1990), and half-eaten salmon carcasses are tell-tale signs of otter predation. Photo: Vegard Lødøen.

Socio-economic conflict: Illegal otter trap, bated with salmon, found along a salmon river in Western Norway in 2021. Photo: Marius Kambestad

Socio-economic conflict: An otter hit by a car as it was dragging a salmon across a road near a river in Western Norway.
Photo: Geir Moen

Socio-economic conflict: Five otters shot by hunters to reduce predation on common eider ducks in Vega, Norway.
Photo: Brynjar Harsvik

3.1. *Ecological interactions*

Increasing abundance of otters across Norway can have significant ecological consequences, particularly when they prey on vulnerable or threatened species.

3.1.1. *Predation on salmonids*

Otters are efficient predators of the Atlantic salmon, a culturally valuable salmonid that is now listed as Near Threatened in Norway due to multiple anthropogenic factors (Forseth et al., 2017; Hesthagen et al., 2021; Box 1). Several studies have documented that otters regularly catch juvenile and adult Atlantic salmon in rivers (e.g., Carss et al., 1990; Cunningham et al., 2002; Kortan et al., 2010; Van Dijk et al., 2020). A salmon tagging study in two Norwegian rivers demonstrated that otter predation can significantly reduce a salmon spawning stock in smaller rivers (Sortland et al., 2023). Predation vulnerability may be further exacerbated by anthropogenic structures, like fish ladders or weirs that aggregate fish and make them easier to catch (Boulêtreau et al., 2018; Cunningham et al., 2002), by habitat alterations, or by reduced water flow caused by hydropower production. Otters also prey on anadromous brown trout (*Salmo trutta*), which has the potential to ignite new conflicts given recent population declines across Norway (Anon. 2015).

3.1.2. *Predation on sea birds*

Although aquatic animals comprise most of the otter diet, they also prey on a variety of birds (e.g., de la Hey, 2008). Otter repopulation has the potential to cause conflicts with bird conservation, because many seabird populations in Norway have declined rapidly (Fauchald et al., 2015; Layton-Matthews et al., 2024). Colony-breeding seabirds have experienced significant reductions over the past decades (Anker-Nilssen et al., 2016; Descamps et al., 2013; Fauchald et al., 2015; Ottersen and Auran, 2007). While some species groups, such as gulls (*Laridae*), appear to be minor sources of prey for otters (Guidos et al., 2023), others, like Atlantic puffins (*Fratercula arctica)* and common guillemots (*Uria aalge*), are often consumed where accessible during the breeding season (S. Guidos pers. obs.). Similarly, the common eider (*Somateria mollissima*) population has declined during the last decade and is now categorised as Vulnerable in Norway (Stokke et al., 2021b). Even though the decline of many seabird species appears to mainly be linked to

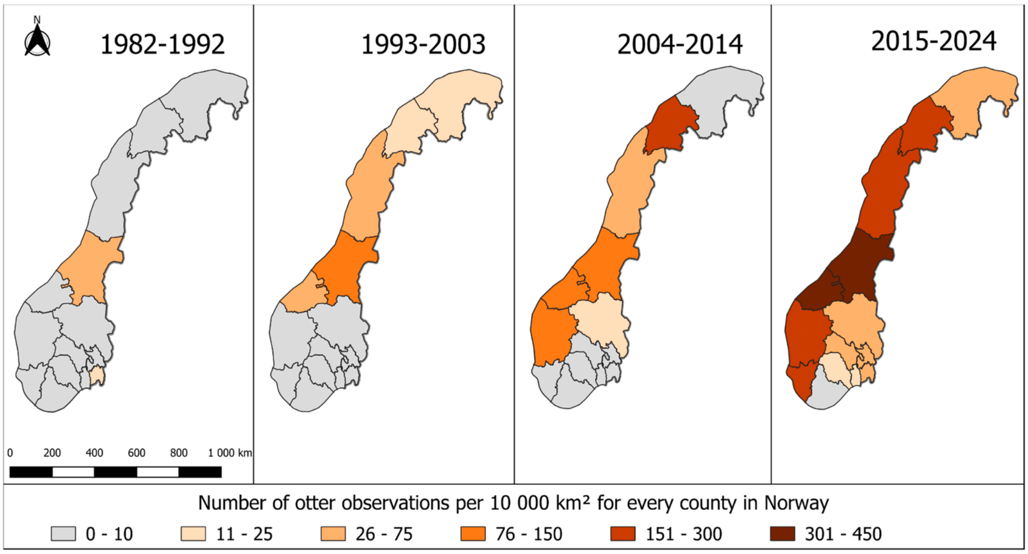

Fig. 2. Number of otter observations per 10,000 km^2 for every county in Norway, binned over four periods; 1982–1992, 1993–2003, 2004–2014 and 2015–2024. Data on otter observations were retrieved from the Artsdatabanken citizen science database (artsdatabanken.no). The search was conducted using the specified criteria provided in the link, covering otter observations recorded in Norway between [01.01.1982] and [31.12.2024] with the criterium "confirmed species identification." After download, observations with date discrepancies were filtered out (N = 368), leaving a total of N = 12,546 observations, accessed on [01.06.2025].

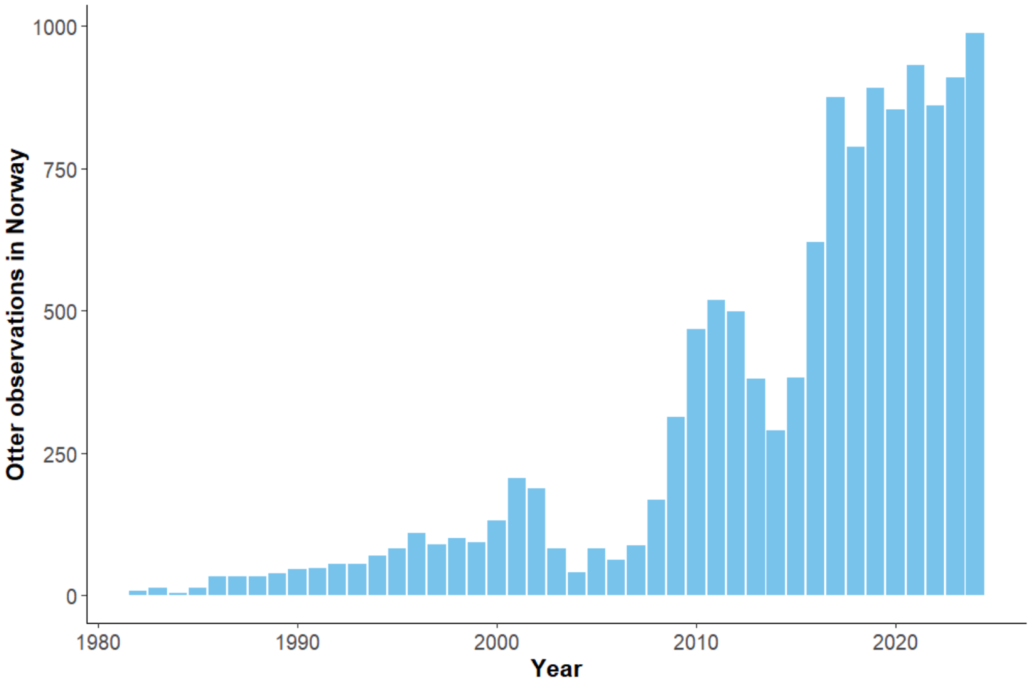

Fig. 3. Number of otter observations per year in Norway from 1982 until 2024. Data on otter observations were retrieved from the Artsdatabanken citizen science database (artsdatabanken.no). The search was conducted using the specified criteria provided in the link, covering otter observations recorded in Norway between [01.01.1982] and [31.12.2024] with the criterium "confirmed species identification." After download, observations with date discrepancies were filtered out (N = 368), leaving a total of N = 12,546 observations, accessed on [01.06.2025].

changing access to important food sources during the breeding season or climate change (Cury et al., 2011), predation by otters has garnered attention. In two instances, otter predation on common eider ducks tended by eiderdown harvesters at Vega Island led to the issuance of culling permits (Follestad et al., 2017; see Box 1) to defuse tensions.

3.1.3. Predation on other species at risk

Otters are opportunistic feeders with a diverse diet, including several species at risk. They can consume freshwater pearl mussels (*Margaritifera margaritifera*) and European crayfish (*Astacus astacus*), listed as Vulnerable and Endangered, respectively, on Norway's red list (Taastrøm and Jacobsen, 1999; Reid et al., 2013; Bakken et al., 2021; Tandberg et al., 2021). Ecosystem alterations driven by anthropogenic factors, including habitat loss, overfishing, and climate change, may precipitate conflicts by further reducing population numbers of threatened prey species. Consequently, otter predation can exacerbate these declines due to compounding impacts (Doherty et al., 2015). For instance, in Scotland, European eels (*Anguilla anguilla*) constituted the primary prey for otters; however, following the significant decline of eel abundance in the 1980s, otters adapted by preying on alternative species, such as salmonids and water birds (Kruuk, 2014). The declining populations of wrasses (*Labridae*), coastal cod (*Gadus morhua*), and eels in parts of Norway (Halvorsen et al., 2017; Craig, 2021; ICES, 2021) could potentially serve as a parallel to the situation observed with eels in Scotland, if these species continue a downward trajectory. As a generalist predator (Dettori et al., 2021), otters could adapt to altered prey availability by shifting their diet to more readily available prey, like Atlantic salmon, crayfish, or eider ducks, thereby increasing predation pressure on these species. If predation persists on rare species, this could result in depensatory mortality, which is likely to lead to negative sentiment towards otters.

3.2. Socio-economic conflicts

The comeback of otters in Norway has sparked both interest and conflict among stakeholder groups about its place in Norwegian nature, including eiderdown harvesters, anglers and local river management organizations, the aquaculture industry, and conservation advocates. Evidence of these disputes is from our own knowledge through longstanding experience with these systems, research articles, and further illustrated by media coverage.

3.2.1. Eiderdown harvesters

In Norway, the tradition of providing shelter for eider ducks to safeguard their eggs, followed by the collection of eider down post-hatching, has been practiced for at least a millennium, and continues to be upheld in some rural coastal communities (Carlsen, 2013; Fageraas, 2016). Following graphic images of deceased eider ducks accompanied by the headline "Otter culling gave life to the eider duck at Vega Island" on Norway's second-largest online news platform (NRK - Norwegian Broadcasting Corporation), calls from politicians affiliated with rural communities to reinstate hunting for otters exemplify how predator management quickly can become contentious (Budalen and Lysvold, 2019; Elveos, 2019). The polarized nature of predator attitudes in Norway, combined with a generally high support for lethal control of these species (Keller et al., 2022) suggests that an increase in otter-related conflicts could lead to divisive politics reminiscent of the controversies surrounding wolves (Krange et al., 2017, 2022; Skogen et al., 2008). Potential outcomes may include a divide between urban and rural areas, disparities in management expectations, and a change in the attitudes towards otters.

3.2.2. Anglers and local river management organizations

Angling is a major recreational activity in Norway, with around 50 % of the population participating at least once a year (Liu et al., 2019). Anglers contribute to rural economies, with expenditures on goods and services surpassing 1.2 billion NOK annually on Atlantic salmon fishing (Andersen and Dervo, 2019). Given that otters primarily consume fish, potential conflicts between recreational anglers and otters, as well as conservation agencies managing otter populations, are anticipated. The decline in Norwegian Atlantic salmon populations, reduced by half since the 1980s due to various anthropogenic stressors (Parrish et al., 1998; The Norwegian Scientific Advisory Committee for Atlantic Salmon, 2025), has exacerbated concerns regarding otter predation (Van dijk et al., 2020). Otter predation on wild Atlantic salmon has led several local river management organizations to request culling permits, and there are reports of renewed illegal culling along certain Norwegian salmon rivers (Van Dijk et al., 2021 and Box 1). Similarly, approximately 7 % of otter carcasses in Denmark contained shotgun pellets, indicating illegal hunting (Elmeros et al., 2012). If other fish species that are coveted by anglers experience a similar decline as Atlantic salmon, and these species are also recognized as part of the otter's diet, comparable conflicts could emerge.

3.2.3. Aquaculture industry

One of the most substantial changes in human use of coastal ecosystems in Norway has been the exponential growth of the aquaculture industry. From a modest production of 600 t in 1970, the industry has grown to produce around 1.35 million t of Atlantic salmon and rainbow trout (*Oncorhynchus mykiss*) in 2019 (Hersoug, 2021). In Norwegian fjords, open net pens containing thousands of Atlantic salmon or rainbow trout present obvious feeding opportunities for otters. There are numerous reports of otters intruding into open net pens in Norway, resulting in economic losses and prompting industry representatives to apply for culling permits (ilaks.no, 2024; Dahl, 2021; kyst.no, 2025). The aquaculture industry in Norway is simultaneously a point of contention, as its negative environmental impact on fjord ecosystems and wild fisheries is well-recognized (Olaussen, 2018), with environmentalists and stakeholders expressing scepticism and concern (Haugen and Olaussen, 2025). Consequently, if the industry is to continue its growth, there is a need to develop effective strategies to manage interactions between wildlife and aquaculture instead of issuing contentious culling permits.

3.2.4. Conservation advocates

Despite the challenges associated with otter rewilding in Norway and the improved population status, some groups still advocate for the continued protection of this predator. Following the publicized conflict over otter predation on eider ducks at Vega, Birdlife, Norway's principal birding non-governmental organization (NGO), promoted the need for coexistence of otters and eider ducks, reinforcing the necessity of maintaining otter protection (NOF avd Nordland, 2019). Similarly, Norway's largest conservation NGO, Naturvernforbundet, alongside the animal rights group NOAH, have opposed culling permits along Norwegian salmon rivers (Folland and Loftesnes, 2007; Løkeland, 2023). Naturvernforbundet argued against culling applications by emphasizing that fish predation is an intrinsic aspect of the otter's behaviour and proof of well-functioning ecosystems, cautioning that approval could set a precedent for otter persecution in other regions. Additionally, researchers have voiced concerns regarding otter culling, highlighting potential trophic cascades, saying “If the otter is removed and more mink appear, it could have negative consequences and at the very least perpetuate the issue [of eider duck predation]” (Solberg and Rønning, 2019).

3.3. Management strategies

As tensions surrounding otter presence continue, management agencies will need effective strategies to address ecological impacts and socio-economic conflicts that supports the long-term persistence of otter populations and coexistence with people.

3.3.1. Hunting and culling

Hunting and culling of predators have traditionally served as management interventions aimed at regulating populations and, in certain contexts, alleviating human–wildlife conflicts (Treves, 2009; Garshelis et al., 2020; Gortázar and Fernandez-de-Simon, 2022). In Norway, lethal control of otters has been permitted only under exceptional circumstances since their legal protection in 1982. These permits have been issued to protect common eider colonies managed by eiderdown harvesters, aquaculture facilities, and, on one occasion, to safeguard salmon spawning stocks. The recent reassessment of the otters’ conservation status may renew discussions on hunting policy or lead to broader use of control permits, given that hunting and culling are common management approaches for numerous species in Norway, including ungulates, large carnivores, and mesopredators, such as red fox (*Vulpes vulpes)* and European pine marten (*Martes martes*) (Andersen et al., 2010; Angerbjörn et al., 2013; Hansen et al., 2019; Helldin, 2000). Despite these precedents, the effectiveness of hunting or culling in reducing socio-economic conflicts involving otters remains uncertain. For example, removing a mature individual with a large territory could trigger immigration of multiple juveniles with smaller ranges, potentially increasing local predator density and exacerbating conflicts rather than resolving them (Bailey and Conradie, 2013; Conradie and Piesse, 2013; Fernández-Gil et al., 2016; Peebles et al., 2013). A study from Norway (Parker et al., 2007) found that harvesting of adult male beavers (*Castor fiber*) negatively affected the timing of females’ parturition, highlighting the potential unforeseen consequences of mammal removal campaigns. Similar issues may arise in otter culling programs, as their removal can lead to compensatory effects in the ecosystem, such as the release of invasive mink from interspecific competition (McDonald et al., 2007). Predator control programs rarely achieve conflict reduction without substantially lowering overall population size, which would conflict with rewilding objectives (Lennox et al., 2018). Targeted removal of “problem individuals” could be effective in specific contexts (Swan et al., 2017), such as otters entering fish farms, provided this behaviour is limited to a small subset of the population. Yet, responses of the public are likely to be polarized where some stakeholders, such as anglers or eiderdown harvesters, may support hunting, while conservation advocates could oppose it. Whether hunting and culling can reduce predation on salmonids, seabirds, or other species while maintaining a sustainable otter population remains unknown.

3.3.2. Relocation

Relocation is considered a humane alternative to killing animals in conflict with human interests (Linnell et al., 1997). Otter relocation has not been widely studied, but a review of animal translocations suggested that success is often limited because relocated animals may suffer high mortality or exhibit strong homing behaviour, while vacant territories are quickly reoccupied by conspecifics (Fischer and Lindenmayer, 2000).When large predators are moved to appropriate areas sufficiently far away, relocation can be effective, but success probably depends on sex, age, and season (Goodrich and Miquelle, 2005; Letty and Marchandeau, 2007; Mukesh et al., 2015). The southernmost region of Norway remains largely uncolonized by otters (Fig. 2) and could represent a candidate area for relocation. However, similar conflicts may arise there, and introducing individuals into areas with existing populations (albeit currently small) could trigger territorial disputes and alter local genetic structure (Mock et al., 2004). To minimize these risks, genetic screening should be integrated into relocation protocols. Assessing genetic diversity in both source and recipient populations can reduce the likelihood of founder effects and genetic bottlenecks, which compromise long-term viability (Mock et al., 2004; Nelson et al., 2024). Molecular markers, such as microsatellites, SNPs, and sex-linked loci are routinely used in conservation programs to determine sex and relatedness, and emerging epigenetic clocks offer promising tools for age estimation (MacDonald et al., 2014; Newediuk et al., 2025; Pérez-González et al., 2023). Incorporating these techniques would allow managers to select individuals that maintain demographic balance and genetic integrity, for example by ensuring appropriate sex ratios and avoiding close kinship among translocated otters. While territorial overlap between males and females has been documented on Gossa Island (Van Dijk and Ulvund, 2018), home range size and spatial dynamics remain poorly understood in other Norwegian habitats, making post-release monitoring essential. Ultimately, relocation may alleviate some conflicts, but its social acceptance will depend on transparent communication of success probabilities and evidence-based practices (Sponarski et al., 2015).

3.3.3. Deterrents or exclusion structures

Human-wildlife conflicts can sometimes be addressed by limiting predator access to sensitive areas, such as prey breeding grounds (e.g., Streeting et al., 2023). Exclusion structures, like fencing, are used to keep nuisance animals out of aquaculture facilities, farms, fish ponds, airports, and other infrastructure (Hayward and Kerley, 2009). Electric fences have been effective at excluding otters from a fish trap to minimize predation on Atlantic salmon in the River Dee in Scotland (Cunningham et al., 2002) and around fish ponds (Halada et al.2011), demonstrating that this measure may work well in predation hot spots. Repellents are also frequently used to alter species' distributions and responses to attractive stimuli (Smith et al., 2010). Methods include visual repellents (scarecrows, predator kites), auditory repellents (loud noises, human sound effects, ultrasonic devices), light repellents (flashing lights, infrared light), olfactory repellents (predator urine, chemical substances), harassment by humans or dogs, and conditioned taste aversion by emetic compounds (e.g., Gustavson et al., 1974). Although several repellents and exclusion structures have been applied on otters (Kurekova, 1999; LeBlanc, 2003; Stepien et al., 2024), we are not aware of quantitative studies testing their efficacy in the wild, nor how it would work along longer stretches of river or at open net pen aquaculture facilities. There is a clear opportunity for testing of repellent candidates for alleviating conflicts regarding otters in Norway, as a strategy for otters, prey species, and people to coexist in shared landscapes.

3.3.4. Habitat restoration

Habitat restoration may be a viable strategy to promote coexistence of otters, prey, and affected stakeholder groups. Interactions with livestock often intensify when natural prey is scarce, for example, Eurasian lynx depredate more domestic sheep in the absence of roe deer (*Capreolus capreolus*; Odden et al., 2008), and grizzly bears (*U. arctos horribilis*) are more likely to attack humans when Pacific salmon runs decline (Artelle et al., 2016). Otters primarily consume fish, and the decline in certain fish species in recent years (Halvorsen et al., 2017; The Norwegian Scientific Advisory Committee for Atlantic Salmon, 2025) could potentially lead to more conflicts. However, bolstering native prey populations through habitat restoration could mitigate such conflicts (Lennox et al., 2025). Salmon rely on suitable shelter to avoid predators, which includes habitat structure, such as woody debris and boulders in rivers, as well as both deep pools and fast flowing water. River channelization and water level reductions due to hydropower may increase salmonid vulnerability to otter predation (e.g., Bakken et al., 2016; Van Dijk et al., 2016) and decrease overall salmonid production (Forseth et al., 2017). Similarly, eel populations have experienced declines in part due to habitat degradation and loss of river connectivity, issues that restoration initiatives can address (Tamario et al., 2019). Consequently, the restoration of fish populations and their habitats should be recognized as a viable strategy for alleviating conflicts between humans and otters in Norway and other regions (Lee and Luan, 2025), although success stories are clearly needed to demonstrate the value and promote best practice for accomplishing this in rivers.

3.3.5. Compensating losses

Economic instruments, such as compensation payments, are widely used in mitigating socio-economic conflicts and encourage coexistence (Bodner, 1995; Dickman et al., 2011; Hamm et al., 2024). For example, in conflicts between otters and carp aquaculture in Germany and Czech Republic, economic compensation has been used to reduce the conflict level (Klenke et al., 2013; Václavíková et al. 2011). In Germany, Austria, Hungary, and Czech Republic, Kranz (2000) found variable levels of desire to cull otters among fish farmers, with the highest inclinations in countries not providing compensation for economic losses. Compensation can either come as a fixed rate prior to the damage or be adjusted to actual loss experienced by the stakeholder. For example, an "otter bonus" is paid for each hectare of fish pond, in addition to a damage compensation scheme to support farmers in Germany (Klenke al., 2013). However, in Czech Republic, reductions in human-otter conflict were not observed, as stakeholders perceived the compensation process as overly bureaucratic and difficult to access (Václavíková et al., 2011). Local river management organizations in Norway could potentially be compensated for the loss of fishing opportunities if otters contribute to declining Atlantic salmon stocks, but this economic action would not resolve impacts on the Atlantic salmon population (e.g., Sortland et al., 2023). Moreover, economic compensation engenders other potential conflicts, particularly when compensation is adjusted to actual loss, because it is generally difficult to document the exact effect of predation on the ecosystem services provided to a given stakeholder (Nyhus et al., 2003). Third, the application for compensation may be considered a significant bureaucratic burden for those that suffer the costs of damage (Václavíková et al. 2011). Since the perception of conservation strategies affects their successful application (Herzon and Mikk, 2007; Junge et al., 2009), investigating the attitudes of stakeholders towards current compensation tools is crucially needed for development of future reconciliation policies (Marshall et al., 2007).

3.4. Pressing challenges and knowledge gaps for effective otter management

To deepen our understanding of the ecological role of otters and address the socio-economic challenges associated with their rewilding, it is important to identify potential issues that may arise following their successful recolonization in Norway. This was done by conducting a horizon scan; a tool within the foresight science framework (Ednie et al., 2023). Foresight science applies structured methods to anticipate future ecological and social challenges and to integrate these insights into management and conservation planning (Ednie et al., 2023). Horizon scanning, as part of this framework, is specifically used to identify knowledge gaps.

3.4.1. In what ways might otter predation affect Atlantic salmon population dynamics?

Otters may play an important ecological role in mitigating pressures on native Atlantic salmon populations by preying on invasive and introduced species that negatively affect salmon. Norwegian Atlantic salmon stocks are subject to multiple anthropogenic stressors, including pathogens and parasites originating from fish farms, alien species, climate change, and genetic introgression of escaped salmon (Forseth et al., 2017; Vollset et al., 2022). For example, the invasive Pink salmon (*Oncorhynchus gorbuscha*) enters Norwegian rivers in July-August of odd-numbered years before spawning in August-September and subsequently dying. In many rivers in northern Norway, mature pink salmon are hyperabundant (Sandlund et al., 2019), potentially making them a readily available prey to otters (Hindar et al., 2020). If otters exploit this resource, this could potentially increase otter abundance in odd-numbered years, leading to greater predation on vulnerable species in years without pink salmon. However, although it remains uncertain whether otters efficiently exploit or ignore this resource, the potential consequences of otters avoiding predation on pink salmon may lead to imbalances in the competitive dynamics between the invasive pink salmon and native salmonids. Other introduced freshwater species in Norway include rainbow trout (*Oncorhynchus mykiss*), signal crayfish (*Pacifastacus leniusculus*) and northern pike (*Esox lucius*; invasive in some regions, native in others); all species known to be predated by otters elsewhere (Britton et al., 2017; Grant and Harrington. 2015; Drake et al., 2023) and that in various ways can impact salmon negatively (Griffiths et al., 2004; Crowl et al., 1992; Falkegård et al., 2023). By preying on invasive species, otters may help reduce their ecological impact on native Atlantic salmon. Similarly, the American mink, another invasive species known to prey on salmon, declines in abundance where otters are present, likely due to competitive exclusion or direct aggression (Guidos, 2019). This suggests that otters could indirectly benefit salmon by suppressing mink populations.

We still lack sufficient knowledge on how otter predation influences Atlantic salmon population structure and viabilityadap. Key uncertainties include how individual traits of salmon influence predation vulnerability, whether increased predation can cause adaptive shits in life-history traits such as time of river entry, how predation patterns vary across river types and habitats, and whether these patterns fluctuate temporally. Understanding these effects is important for predicting how predation influences Atlantic salmon spawning success, how it may differentially impact populations across river systems, and for providing a foundation for evidence-based, river-specific management strategies. Additionally, it remains unclear whether predation on already depleted populations could lead to depensatory effects, increasing the risk of local extinction in some rivers. Another interesting case is the potential for selective predation by otters on salmon with escaped farmed fish ancestry. For example, Atlantic salmon fry with farmed genes show reduced anti-predator responses (Houde et al., 2010) and increased predator susceptibility (Solberg et al., 2020). If this is valid also for adults, it could be predicted that otters may have the capacity to limit the transmission of farmed fish genes within the population if the selection is sufficiently strong. Furthermore, otter predation on escaped farmed salmon carrying pathogens could slow the spread of disease, a phenomenon observed in other predator-prey relationships (Duffy et al., 2008). Therefore, understanding how predation impacts long-term viability of spawning stocks can be an important attribution to adaptive management of otters.

3.4.2. How have otters co-evolved with Atlantic salmon?

Evolutionary arms races are widely described between predators and their prey, because selective predation drives the fitness landscape for trait combinations, steering evolution (Netz et al., 2022; Scheuerl et al., 2019; Johnson and Belk, 2020). Loss of predators thus has the potential to exert a relatively extreme and swift effect on the phenotypes of prey. Recognizing otters as predators and responding to the threat of predation must historically have been an adaptive phenotype for Atlantic salmon in Norway, which may have been suppressed via two mechanisms; 1) salmon that fail to account for predation risk in life history strategies (e.g., by entering rivers early when returning from the sea or lingering in the river after spawning) have greater reproductive success in the absence of predators, driving evolution of life history phenotypes that are highly vulnerable when predators return; or 2) introgression with escaped farmed salmon has introduced genes that increase susceptibility to predation (as shown with juvenile salmon e.g., Solberg et al., 2020). Such effects may have been exacerbated by local hatchery programs by non-random collection of broodstock fish (often large, early migrators), by selection for traits that increase survival in tanks rather than in natural habitats, and by favouring genotypes of farmed fish (Hagen et al., 2019). Comparing predator avoidance behaviour and life-history strategies in salmon stocks with and without a continuous sympatry with otters, preferably coupled with genetic studies to quantify effects of genetic introgression or hatchery programs, could help illuminate the importance of predator-prey coevolution for salmon survival in Norwegian rivers.

3.4.3. How do otters contribute to the management of invasive mink?

American mink was introduced to Norway in 1927 for the purpose of fur farming (Bevanger and Henriksen, 1995), with subsequent escapees eventually invading 85 % of mainland Norway (Bevanger and Henriksen, 1995), resulting in negative impacts on native prey species and competitive inferiors. The dispersal of mink was likely aided by the absence of their main competitor, the otter. Otters are known to exhibit aggressive behaviour towards mink, and studies have found mink hair in otter scats, suggesting predation (Bonesi et al., 2000; Grigor'ev and Egorov, 1969). Previous research indicates that reestablishing otter populations can lead to reduced mink densities and significant dietary shifts in mink, from primarily piscivorous diets to terrestrial prey, such as mammals and birds (Bonesi and Macdonald, 2004; Bonesi et al., 2004a). Increased habitat heterogeneity promotes cohabitance of mink and otters (Bonesi and Macdonald, 2004), and it is therefore possible that coastal zones, being more heterogeneous than limnic ecosystems, will facilitate such co-occurrence, as is seen between coastal-living mink and the North American river otter (*Lontra canadensis*; Ben-David et al., 1996). Preliminary camera trap studies indicate that mink activity patterns and sighting frequency differs between Norwegian coastal areas with and without otters (Kjoberg, 2023). Similar studies with increased sampling effort could help determine potential changes to mink population densities, habitat use, or behaviour resulting from increased competition from otters.

3.4.4. What is the home range and habitat use of otters?

Otters are territorial predators that require year-round access to high-energy food and sufficient space. Reported home range sizes for Eurasian otters vary from approximately 5–30 km of river (Erlinge, 1968; Durbin, 1996; Quaglietta et al., 2019), with estimated densities ranging from one individual per 2.3–7.8 km of river (Quaglietta et al., 2015; Sittenthaler et al., 2015; Gil-Sánchez and Antorán-Pilar, 2020). Territoriality appears to be influenced by river size, prey availability, and energetic demands, suggesting that small Norwegian rivers (<10 km) may support only a few adult otters. However, home range size likely varies with other habitat features such as connectivity, shelter, and seasonal prey dynamics. To better understand otter spatial requirements and energetic needs, novel biotelemetry tools offer promising insights. Rosell et al. (2021) demonstrated that tri-axial accelerometers and GPS loggers can successfully capture fine-scale behaviours, such as hunting, resting, and grooming in captive otters. Investigating how otter densities, home range size, and habitat use vary among environments is important to predict outcomes of a variety of management strategies. For example, when combined with detailed data on Norway's salmon-bearing rivers, this technology could help evaluate how river size and prey density shape otter territoriality, home range size, and behavioural plasticity in anadromous riverine environments. Moreover, such tools may improve assessments of the impact of legal (or illegal) culling along rivers and coastlines or help in monitoring the behaviour of relocated animals. It could also be used to inform the development of non-lethal mitigation strategies, such as deterrents or exclusion structures, to understand their effectiveness.

3.4.5. How to balance socio-economic conflicts when deciding on otter management

Public trust in wildlife management policy and authorities in Norway is generally high (Manfredo et al., 2022). However, social acceptance varies among stakeholder groups and countries, particularly regarding lethal control, such as hunting or culling, and attitudes also differ across species (Krange et al., 2012). Support for such measures is strongly influenced by underlying value orientations: individuals with dominion views of nature tend to favor lethal control, whereas those with mutualist views are less supportive (Jacobs et al., 2014; Straka et al., 2020). Understanding these broader social values and perceptions is essential for tailoring management strategies to local contexts (Teel et al., 2022). For instance, otters were generally well accepted by the public in Romania, though attitudes varied with perceived economic impacts and cultural norms (Gridan et al., 2025). In Norway, knowledge about the attitudes, social values, and perspectives of stakeholders towards various management strategies remains limited. Systematic mapping of these perspectives is therefore critical for informed decision-making. For the stakeholder groups affected by the socio-economic conflicts identified in this perspective paper, there is insufficient information regarding their size and the complexity of their perceptions, which poses a significant challenge for making informed management decisions. Such efforts will help design management options that align with community values, improve social legitimacy, and foster cooperation in conservation initiatives that encourage coexistence between otters and people.

4. Lessons learned

The recolonization of otters in Norway exemplifies successful rewilding but has also reignited conflicts. Any rewilding initiative in areas where human stakeholders interact and use the environment carries the potential for conflict, particularly when the restored species affects livelihoods, resource access, or cultural values. As explored in this paper using the case study of otters in Norway, predator rewilding involves considerations across both ecological and socio-economic domains, requiring management strategies that mitigate conflict and foster conditions for human-wildlife coexistence.

Investigating the ecological consequences of predator rewilding in the context of altered ecosystems is valuable for effective management and conflict anticipation. As illustrated by the otter case study, the ecological interactions involving the reintroduced predator might not necessarily revert to historical or "reference" conditions. Predator rewilding efforts aim to restore wilderness and repair ecosystem functioning by reinstating trophic interactions that were lost due to the previous disappearance of key species. However, setting a recovery target for a such projects can be challenging. Targets may refer to population size or to changes in ecosystem functioning post-rewilding. Recovery is often context-specific and scale-dependent, and the "true" reference condition, whether historic population levels or ecosystem functioning, is almost always unknown. The ecosystems to which predators are reintroduced have often undergone significant alterations over time, impacted by gradual changes or ecological regime shifts (sometimes caused by the absence of the predator, see Colman et al., 2014; Leo et al., 2019), as well as natural or anthropogenic influences leading to altered species composition and biomass (Ratajczak et al., 2018; Kuijper et al., 2024). Therefore, forecasting ecological outcomes of rewilding is essential for understanding the trophic implications of predator reintroduction (Ulanowicz et al., 2014; Perino et al., 2019; Bartley et al., 2019; Rodriguez-Recio et al., 2022).

Addressing socio-economic conflicts in predator rewilding should involve identifying the groups affected, characterizing the nature of emerging tensions, and involving stakeholders in management decisions. In the case of otter rewilding in Norway, stakeholders have diverse economic interests, traditions, and beliefs about nature which produce vastly different perspectives on the species' return. Given these socio-demographic complexities, the early identification and mapping of stakeholders prior to rewilding efforts is critical for mitigating potential conflicts (Sperry and Jetter, 2019; Auster et al., 2020). Although less optimal than assessments prior to rewilding, mapping social values and attitudes during or after rewilding efforts can facilitate the identification and characterization of the conflict, while simultaneously indicating which aspects need to be addressed to mitigate socio-ecological tensions (Marshall et al., 2007). Further, it is valuable to involve stakeholders in decision-making processes (Reed et al., 2008). To this end, König et al. (2021) propose an integrated framework designed to enhance participation, promote coexistence, and address human–wildlife conflicts by combining methodologies that assess stakeholder interests, their influence on governance, and the reciprocal relationship between research and management outcomes.

Facilitating species co-occurrence necessitates a diverse array of management strategies in predator rewilding scenarios (Fiasco et al., 2022; Carter and Linnell, 2016; Hamm et al., 2024). Management should be adaptive rather than static, integrating ongoing monitoring and research to inform and adjust interventions based on collected data (Richardson et al., 2020; Franklin et al., 2007). In the context of otters in Norway, we identified various management options aimed at mitigating conflicts, with many strategies yet to be tested. Using an interdisciplinary approach that includes ecological and social dimensions is important for effective management and conflict resolution (White and Ward, 2010). Similarly, the successful rewilding of large carnivores in Europe has benefited from supportive public opinion, favorable legislation, improved habitat quality, and robust monitoring alongside context-dependent management strategies (Chapron et al., 2014). This underscores the critical role of adaptive management that encompasses social and ecological factors in rewilding initiatives.

The effective implementation of management strategies, especially novel methods designed to encourage species coexistence, necessitates rigorous research to identify and characterize emerging challenges and highlight positive and negative roles of the species in question. In addition to monitoring, researchers should conduct pre-emptive investigations before implementation. One framework for generating predictions and identifying key research priorities in rewilding and wildlife management is foresight science. This approach proactively explores knowledge gaps by examining historical context, analyzing current trends, and anticipating future trajectories in coupled ecological and social systems. Ednie et al. (2023) offer an illustrative model comprising steps, such as defining scope, gathering inputs (e.g., through horizon scanning), analyzing signals, interpreting data, determining actions, and implementing outcomes. This methodology can support the achievement of conservation goals. Integrating insights from foresight science into existing frameworks, such as the rewilding complex ecosystems framework by Perino et al. (2019), could enhance the success rates of predator rewilding initiatives, both ecologically and socially.

5. Conclusion

This paper explores the ecological and socio-economic dimensions of predator rewilding, using the otter recolonization in Norway as a case study. We identified key management strategies and research gaps relevant to future conservation efforts. The Norwegian context offers insights applicable both across the otter's range and to broader predator rewilding initiatives. Drawing on four central themes (ecological interactions, socio-economic conflict, management approaches, and research needs), we show that predator rewilding is having both ecological and societal impacts. Understanding these impacts through research, especially in ecosystems that have undergone substantial changes since the target species was last present, is important for adaptive management that mitigates conflict and supports coexistence. Lessons from otter recolonization in Norway and other rewilding initiatives can inform the design and implementation of future rewilding efforts.

CRediT authorship contribution statement

David N. Carss: Writing – review & editing, Writing – original draft. **Hanssen Erlend Mjelde:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Steven Guidos:** Writing – review & editing, Writing – original draft. **Marius Kambestad:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Conceptualization. **Knut Wiik Vollset:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Morgan L. Piczak:** Writing – review & editing, Writing – original draft, Methodology. **Robert J. Lennox:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Gaute Velle:** Writing – review & editing, Writing – original draft, Visualization, Methodology. **Lene K. Sortland:** Writing – review & editing, Writing – original draft. **Jiska van Dijk:** Writing – review & editing, Writing – original draft. **Oddgeir Andersen:** Writing – review & editing, Writing – original draft. **Rose Keller:** Writing – review & editing, Writing – original draft. **Frank N. Rosell:** Writing – review & editing, Writing – original draft. **Sigrid Engen:** Writing – review & editing, Writing – original draft.

Declaration of Generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author(s) used ChatGPT 5 through Microsoft Copilot in order to correct grammar and spelling, as well as to find synonyms and variation in expressions to make the text more fluid. After using this tool/service, the author (s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data was downloaded from citizen science database with link and search terms included in the paper

References

Abrams, P.A., 2000. The evolution of predator-prey interactions: theory and evidence. Annu. Rev. Ecol. Syst. 31 (1), 79–105.

Andersen, O., & Dervo, B.K. (2019). The consumption of goods and services by anglers and hunters in Norway in 2018. Norwegian Institute for Nature Research (NINA) (Report No. 1605). ⟨http://hdl.handle.net/11250/2580264⟩.
Andersen, R.E., Lund, E., Solberg, E.J., Saether, B.E., 2010. Ungulates and their management in Norway. European ungulates and their management in the 21st century, pp. 14–36.
Angerbjörn, A., Eide, N.E., Dalén, L., Elmhagen, B., Hellström, P., Ims, R.A., Henttonen, H., 2013. Carnivore conservation in practice: replicated management actions on a large spatial scale. J. Appl. Ecol. 50 (1), 59–67.
Anker-Nilssen, T., Strøm, H., Barrett, R., Bustnes, J.O., Christensen-Dalsgaard, S., Descamps, S., Erikstad, K.-E., Hanssen, S.A., Lorentsen, S.-H., Lorentzen, E., 2016. Key-site monitoring in Norway 2015, including Svalbard and Jan Mayen. SEAPOP Short Rep. 14, 1-2016.
Anon, 2015. Råd om beskatning av laks og sjøørret for perioden 2016 til 2018. Rapport fra Vitenskapelig råd for lakseforvaltning nr 7, 138.
Araújo, M.B., Alagador, D., 2024. Expanding European protected areas through rewilding. Curr. Biol. 34 (17), 3931–3940.
Artelle, K.A., Anderson, S.C., Reynolds, J.D., Cooper, A.B., Paquet, P.C., Darimont, C.T., 2016. Ecology of conflict: marine food supply affects human-wildlife interactions on land. Sci. Rep. 6 (1), 25936.
Auster, R.E., Puttock, A., Brazier, R., 2020. Unravelling perceptions of Eurasian beaver reintroduction in Great Britain. Area 52 (2), 364–375.
Avila, A.B., Corriale, M.J., Di Francescantonio, D., Picca, P.I., Donadio, E., Di Bitetti, M.S., De Angelo, C., 2025. Multiple Effects of Capybaras on Vegetation Suggest Impending Impacts of Jaguar Reintroduction. Appl. Veg. Sci. 28 (1), e70017.
Bailey, A., and Conradie, B. (2013). The effect of predator culling on livestock losses: Caracal control in Cooper Hunting Club, 1976-1981. ⟨https://open.uct.ac.za/handle/11427/19390⟩.
Bakken, T.H., Forseth, T., Harby, A., Alfredsen, K., Arnekleiv, J.V., Berg, O.K., Casas-Mulet, R., Charmasson, J., Greimel, F., and Halley, D. (2016). Miljøvirkninger av effektkjøring: Kunnskapsstatus og råd til forvaltning og industri. ⟨https://brage.nina.no/nina-xmlui/handle/11250/2391709⟩.
Bakken, T., Skahjem, N., & Olsen, K.M. (2021). Bløtdyr: Vurdering av elvemusling Margaritifera margaritifera for Norge. *Norsk rødliste for arter*.
Bakker, E.S., Svenning, J.C., 2018. Trophic rewilding: impact on ecosystems under global change. Philos. Trans. R. Soc. B Biol. Sci. 373 (1761), 20170432.
Bartley, T.J., McCann, K.S., Bieg, C., Cazelles, K., Granados, M., Guzzo, M.M., McMeans, B.C., 2019. Food web rewiring in a changing world. Nat. Ecol. Evol. 3 (3), 345–354.
Bauer, N., Wallner, A., Hunziker, M., 2009. The change of European landscapes: Human-nature relationships, public attitudes towards rewilding, and the implications for landscape management in Switzerland. J. Environ. Manag. 90 (9), 2910–2920.
Ben-David, M., Bowyer, R.T., Faro, J.B., 1996. Niche separation by mink and river otters: coexistence in a marine environment. Oikos 41–48.
Berg, B.O.N. (2025). Human-otter conflicts and evaluation of non-lethal mitigation measures (Master's thesis). Inland Norway University. ⟨https://hdl.handle.net/11250/3204456⟩.
Bevanger, K., Henriksen, G., 1995. The distributional history and present status of the American mink (Mustela vison Schreber, 1777) in Norway. Ann. Zool. Fenn. 11–14. ⟨https://www.jstor.org/stable/23735558⟩.
Bodner, M., 1995. Fish loss in Austrian fish-ponds as a result of otter (Lutra lutra L.) predation. IUCN Otter Spec. Group Bull. 12, 3–10.
Bombieri, G., Naves, J., Penteriani, V., Fernández-Gil, A., López-Bao, J.V., Fedriani, J.M., Delgado, M.M., 2019. Brown bear attacks on humans: a worldwide perspective. Sci. Rep. 9, 8573. https://doi.org/10.1038/s41598-019-44341-w.
Bombieri, G., Penteriani, V., Almasieh, K., Ambarlı, H., Ashrafzadeh, M.R., Das, C.S., del Mar Delgado, M., 2023. A worldwide perspective on large carnivore attacks on humans. PLoS Biol. 21 (1), e3001946.
Bonesi, L., Chanin, P., Macdonald, D.W., 2004a. Competition between Eurasian otter Lutra lutra and American mink Mustela vison probed by niche shift. Oikos 106 (1), 19–26. https://doi.org/10.1111/j.0030-1299.2004.12763.x.
Bonesi, L., Dunstone, N., O'Connell, M., 2000. Winter selection of habitats within intertidal foraging areas by mink (Mustela vison). J. Zool. 250 (3), 419–424.
Bonesi, L., Macdonald, D.W., 2004. Differential habitat use promotes sustainable coexistence between the specialist otter and the generalist mink. Oikos 106 (3), 509–519.
Boulêtreau, S., Gaillagot, A., Carry, L., Tétard, S., De Oliveira, E., Santoul, F., 2018. Adult Atlantic salmon have a new freshwater predator. PLoS One 13 (4), e0196046.
Britton, J.R., Berry, M., Sewell, S., Lees, C., Reading, P., 2017. Importance of small fishes and invasive crayfish in otter Lutra lutra diet in an English chalk stream. Knowl. Manag. Aquat. Ecosyst. (418), 13.
Budalen, A., & Lysvold, S.S. (2019, April 5). Her har oteren herjet i verdensarvområdet - Nå vil Sp-topp ha fri jakt. NRK. Retrieved from ⟨https://www.nrk.no/nordland/her-har-oteren-herjet-i-verdensarvomradet_-na-vil-sp-topp-ha-fri-jakt-1.14504601⟩.
Butler, J.R., Marzano, M., Pettorelli, N., Durant, S.M., du Toit, J.T., Young, J.C., 2021. Decision-making for rewilding: an adaptive governance framework for social-ecological complexity. Front. Conserv. Sci. 2, 681545.
Callan, R., Nibbelink, N.P., Rooney, T.P., Wiedenhoeft, J.E., Wydeven, A.P., 2013. Recolonizing wolves trigger a trophic cascade in Wisconsin (USA). J. Ecol. 101 (4), 837–845.
Carlsen, T.H. (2013). Nordisk ærfugldun. Kunnskapsutveksling mellom Norge, Island, Grønland og Færøyene. Bioforsk Report. Vol.8 Nr. 108 2013.
Caro, T., 2010. Conservation by Proxy: Indicator, Umbrella, Keystone, Flagship, and Other Surrogate Species. Island Press.
Carss, D.N., Kruuk, H., Conroy, J.W.H., 1990. Predation on adult Atlantic salmon, Salmo salar L., by otters, Lutra lutra (L.), within the River Dee system, Aberdeenshire, Scotland. J. Fish. Biol. 37 (6), 935–944. https://doi.org/10.1111/j.1095-8649.1990.tb03597.x.
Carter, N.H., Linnell, J.D., 2016. Co-adaptation is key to coexisting with large carnivores. Trends Ecol. Evol. 31 (8), 575–578.
Carver, S., Convery, I., Hawkins, S., Beyers, R., Eagle, A., Kun, Z., Soulé, M., 2021. Guiding principles for rewilding. Conserv. Biol. 35 (6), 1882–1893.
Chapron, G., Kaczensky, P., Linnell, J.D., Von Arx, M., Huber, D., Andrén, H., Boitani, L., 2014. Recovery of large carnivores in Europe's modern human-dominated landscapes. science 346 (6216), 1517–1519.
Christensen, H. (1995). The otter Lutra lutra population in Norway during the 20th century. Determinants of Otter Lutra lutra Distribution in Norway: Effects of Harvest, Polychlorinated biphenyls (PCBs), Human Population Density, and Composition with Mink (Mustela vison). Dissertation, Univ. of Trondheim.
Colman, N.J., Gordon, C.E., Crowther, M.S., Letnic, M., 2014. Lethal control of an apex predator has unintended cascading effects on forest mammal assemblages. Proc. R. Soc. B Biol. Sci. 281 (1782), 20133094.
Conradie, B., and Piesse, J. (2013). The effect of predator culling on livestock losses: Ceres, South Africa, 1979-1987. ⟨https://open.uct.ac.za/handle/11427/19445⟩.
Corlett, R.T., 2016. Restoration, reintroduction, and rewilding in a changing world. Trends Ecol. Evol. 31 (6), 453–462.
Craig, D.C. (2021). Cod on the dive: investigating Atlantic cod of the Inner Oslofjord during population decline.
Crowl, T.A., Townsend, C.R., McIntosh, A.R., 1992. The impact of introduced brown and rainbow trout on native fish: the case of Australasia. Rev. Fish. Biol. Fish. 2, 217–241.
Cunningham, P.D., Brown, L.J., Harwood, A.J., 2002. Predation and scavenging of salmon carcasses along spawning streams in the Scottish Highlands. Final Rep. Atl. Salmon Trust 3–6.
Cury, P.M., Boyd, I.L., Bonhommeau, S., Anker-Nilssen, T., Crawford, R.J.M., Furness, R.W., Mills, J.A., Murphy, E.J., Österblom, H., Paleczny, M., Piatt, J.F., Roux, J.-P., Shannon, L., Sydeman, W.J., 2011. Global Seabird Response to Forage Fish Depletion—One-Third for the Birds. Science 334 (6063), 1703–1706. https://doi.org/10.1126/science.1212928.
Dahl, M. (2021). Cermaq - en oter til besvær. metalsupply.no. Retrieved from ⟨https://www.metalsupply.no/article/view/815631/cermaq_en_oter_til_besvaer⟩.
de la Hey, D.C., 2008. The importance of birds in the diet of otter Lutra lutra on Shapwick Heath. Biosci. Horiz. 1 (2), 143–147.
Descamps, S., Strøm, H., Steen, H., 2013. Decline of an arctic top predator: Synchrony in colony size fluctuations, risk of extinction and the subpolar gyre. Oecologia 173 (3), 1271–1282. https://doi.org/10.1007/s00442-013-2701-0.
Dettori, E.E., Balestrieri, A., Zapata-Perez, V.M., et al., 2021. Distribution and diet of recovering Eurasian otter (Lutra lutra) along the natural-to-urban habitat gradient (river Segura, SE Spain). Urban Ecosyst. 24, 1221–1230. https://doi.org/10.1007/s11252-021-01109-3.

Dhanwatey, H.S., Crawford, J.C., Abade, L.A., Dhanwatey, P.H., Nielsen, C.K., Sillero-Zubiri, C., 2013. Large carnivore attacks on humans in central India: a case study from the Tadoba-Andhari Tiger Reserve. Oryx 47 (2), 221–227. https://doi.org/10.1017/S0030605311001803.
Dickman, A.J., Macdonald, E.A., Macdonald, D.W., 2011. A review of financial instruments to pay for predator conservation and encourage human–carnivore coexistence. Proc. Natl. Acad. Sci. 108 (34), 13937–13944. https://doi.org/10.1073/pnas.1012972108.
Doherty, T.S., Dickman, C.R., Nimmo, D.G., Ritchie, E.G., 2015. Multiple threats, or multiplying the threats? Interactions between invasive predators and other ecological disturbances. Biol. Conserv. 190, 60–68.
Donadio, E., Di Martino, S., Heinonen, S., 2022. Rewilding Argentina: lessons for the 2030 biodiversity targets. Nature 603 (7900), 225–227.
Drake, L.E., Cuff, J.P., Bedmar, S., McDonald, R., Symondson, W.O., Chadwick, E.A., 2023. Otterly delicious: Spatiotemporal variation in the diet of a recovering population of Eurasian otters (Lutra lutra) revealed through DNA metabarcoding and morphological analysis of prey remains. Ecol. Evol. 13 (5), e10038.
Drenthen, M., 2018. Rewilding in cultural layered landscapes. Environ. Values 27 (4), 325–330.
Duffy, M.A., Hall, S.R., 2008. Selective predation and rapid evolution can jointly dampen effects of virulent parasites on Daphnia populations. Am. Nat. 171 (4), 499–510.
Duplaix, N., and Savage, M. (2022). The global otter conservation strategy. eScholarship, University of California. ⟨https://www.academia.edu/download/58048987/IUCN-Otter-Report-Dec_17-Master-Doublepage.pdf⟩.
Durbin, L.S., 1996. Individual differences in spatial utilization of a river-system by otters Lutra lutra. Acta Theriol. 41 (2). ⟨http://agro.icm.edu.pl/agro/element/bwmeta1.element.agro-article-6f0ce723-336c-460f-974d-d6b5abb9caab⟩.
Ednie, G., Kapoor, T., Koppel, O., Piczak, M.L., Reid, J.L., Murdoch, A.D., Cooke, S.J., 2023. Foresight science in conservation: Tools, barriers, and mainstreaming opportunities. Ambio 52 (2), 411–424.
Egoh, B.N., Nyelele, C., Holl, K.D., Bullock, J.M., Carver, S., Sandom, C.J., 2021. Rewilding and restoring nature in a changing world. Plos One 16 (7), e0254249.
Elmeros, M., Holm, T.E., Haugaard, L., Madsen, A.B., 2012. Prevalence of embedded shotgun pellets in protected and in legally hunted medium-sized carnivores in Denmark. Eur. J. Wildl. Res. 58 (4), 715–719. https://doi.org/10.1007/s10344-012-0621-7.
Elveos, B.-K. (2019, June 27). Oterjakt ga liv til ærfuglene på Vega - Alle ungene har overlevd i år. NRK. Retrieved from ⟨https://www.nrk.no/nordland/oterjakt-ga-liv-til-aerfuglene-pa-vega.-_-alle-ungene-har-overlevd-i-ar-1.14612312⟩.
Erlinge, S., 1968. Territoriality of the otter Lutra lutra L. Oikos 81–98.
Fageraas, K., 2016. Housing Eiders–Making Heritage: The Changing Context of the Human–Eider Relationship in the Vega Archipelago. Norway. In Animal Housing and Human-Animal Relations. Routledge, pp. 82–99. ⟨https://books.google.com/books?hl=enandlr=andid=tdYmDAAAQBAJandoi=fndandpg=PA82anddq=eider+tending+norwayandots=ISbunYHe01andsig=f6ttJfhGYWbsOW3jy3bsyNd71DA⟩.
Falkegård, M., Lennox, R.J., Thorstad, E.B., Einum, S., Fiske, P., Garmo, Ø.A., Forseth, T., 2023. Predation of Atlantic salmon across ontogenetic stages and impacts on populations. Can. J. Fish. Aquat. Sci. 80 (10), 1696–1713.
Farwig, N., Sprenger, P.P., Baur, B., Böhning-Gaese, K., Brandt, A., Eisenhauer, N., Mosbrugger, V., 2025. Identifying major factors for success and failure of conservation programs in Europe. Environ. Manag. 75 (3), 425–443.
Fauchald, P., Anker-Nilssen, T., Barrett, R., Bustnes, J.O., Bårdsen, B.-J., Christensen-Dalsgaard, S., Descamps, S., Engen, S., Erikstad, K.E., and Hanssen, S.A. (2015). The status and trends of seabirds breeding in Norway and Svalbard. ⟨https://brage.nina.no/nina-xmlui/bitstream/handle/11250/2397703/1151.pdf?sequence=3⟩.
Fernández-Gil, A., Naves, J., Ordiz, A., Quevedo, M., Revilla, E., Delibes, M., 2016. Conflict misleads large carnivore management and conservation: Brown bears and wolves in Spain. PLoS One 11 (3), e0151541.
Fiasco, V., Massarella, K., 2022. Human-wildlife coexistence: business as usual conservation or an opportunity for transformative change? Conserv. Soc. 20 (2), 167–178.
Fischer, J., Lindenmayer, D.B., 2000. An assessment of the published results of animal relocations. Biol. Conserv. 96 (1), 1–11.
Folland, K., & Loftesnes, V.S. (2007, June 4). Oter skremmer laks. NRK. ⟨https://www.nrk.no/vestland/oter-skremmer-laks-1.2793130⟩.
Follestad, A., Moe, B., & Thomassen, J. (2017). Sammenstilling av eksisterende kunnskap om påvirkningsfaktorer og effekter på ærfugl og ærfugldrift i Vegaøyan verdensarvområde.
Foreman, D., 2004. Rewilding North America: A vision for conservation in the 21st century. Island Press.
Forseth, T., Barlaup, B.T., Finstad, B., Fiske, P., Gjøsæter, H., Falkegård, M., Hindar, A., Mo, T.A., Rikardsen, A.H., Thorstad, E.B., 2017. The major threats to Atlantic salmon in Norway. ICES J. Mar. Sci. 74 (6), 1496–1513.
Forskrift om fiske etter anadrome laksefisk i sjøen § 4. (2021). Lovdata. ⟨https://lovdata.no/dokument/SF/forskrift/2021-03-15-797⟩.
Franklin, T.M.F., Helinski, R.H., & Manale, A.M. (2007). Using adaptive management to meet conservation goals.
Gallardo, J.D., Forman, D., 2024. Eurasian otter (Lutra lutra) diet and its trophic implications on freshwater systems in the UK and Ireland. In: Yoxon, G., Yoxon, B., de Silva, P., Wilson, L., Bureau, B. (Eds.), OTTER (Broadford). International Otter Survival Fund, Broadford, Australia, pp. 25–40.
Garshelis, D.L., Noyce, K.V., St-Louis, V., 2020. Population reduction by hunting helps control human–wildlife conflicts for a species that is a conservation success story. PLoS One 15 (8), e0237274.
Gil-Sánchez, J.M., Antorán-Pilar, E., 2020. Camera-trapping for abundance estimation of otters in seasonal rivers: a field evaluation. Eur. J. Wildl. Res. 66 (5), 72. https://doi.org/10.1007/s10344-020-01409-7.
Goodrich, J.M., Miquelle, D.G., 2005. Translocation of problem Amur tigers Panthera tigris altaica to alleviate tiger-human conflicts. Oryx 39 (4), 454–457.
Gortázar, C., Fernandez-de-Simon, J., 2022. One tool in the box: the role of hunters in mitigating the damages associated to abundant wildlife. Eur. J. Wildl. Res. 68 (3), 28.
Grant, K.R., Harrington, L.A., 2015. Fish selection by riverine Eurasian otters in lowland England. Mammal. Res. 60, 217–231.
Gridan, A., Paşca, C., Ionescu, G., Sîrbu, G., Spătaru, C., Ionescu, O., Hardalau, D., 2025. Spatial Forecasting and Social Acceptance of Human-Wildlife Conflicts Involving Semi-Aquatic Species in Romania. Diversity 17 (8), 559.
Griffiths, S.W., Collen, P., Armstrong, J.D., 2004. Competition for shelter among over-wintering signal crayfish and juvenile Atlantic salmon. J. Fish. Biol. 65 (2), 436–447.
Grigor'ev, N. D., & Egorov, Y. E. (1969). The biocenotic connections of the mink with the common otter in the Bashkirian SSSR. Á/Sbornik trudov Nauchno-issledovatel skogo instituta zhivotnovodstva Syr'ya Pushniny, 22, 26Á.
Guidos, S.A. (2019). Interactions between Eurasian otters (Lutra lutra) and American mink (Neovison vison) in western Norway: A camera trap study over space and time (Master's thesis). University of Bergen. ⟨https://hdl.handle.net/1956/20745⟩.
Guidos, S., van Dijk, J., Systad, G., Landa, A., 2023. Colony-nesting gulls restrict activity levels of a native top carnivore during the breeding season. Remote Sens. Ecol. Conserv. 9 (4), 527–539. https://doi.org/10.1002/rse2.326.
Gusset, M., Maddock, A.H., Gunther, G.J., Szykman, M., Slotow, R., Walters, M., Somers, M.J., 2008. Conflicting human interests over the re-introduction of endangered wild dogs in South Africa. Biodivers. Conserv. 17, 83–101.
Gustavson, C.R., Garcia, J., Hankins, W.G., Rusiniak, K.W., 1974. Coyote Predation Control by Aversive Conditioning. Science 184 (4136), 581–583. https://doi.org/10.1126/science.184.4136.581.
Hagen, I.J., Jensen, A.J., Bolstad, G.H., Diserud, O.H., Hindar, K., Lo, H., Karlsson, S., 2019. Supplementary stocking selects for domesticated genotypes. Nat. Commun. 10 (1), 199.
Halada, R., Rutkayova, J., Adámek, Z., GUČÍK, M., 2011. Fish electrical repeller ELZA2 as a prevention of European otter (Lutra lutra) access to fish farming facilities. Proc. 46th Croat. 6th Int. Symp Agric. Opatija. Croat. 777, 781. ⟨https://citeseerx.ist.psu.edu/document?repid=rep1andtype=pdfanddoi=e612787c5f2a24a918e17a6d7bef274f65f0dea1⟩.
Halvorsen, K.T., Larsen, T., Sørdalen, T.K., Vøllestad, L.A., Knutsen, H., Olsen, E.M., 2017. Impact of harvesting cleaner fish for salmonid aquaculture assessed from replicated coastal marine protected areas. Mar. Biol. Res. 13 (4), 359–369. https://doi.org/10.1080/17451000.2016.1262042.
Hamm, J., Holmes, G., Martin-Ortega, J., 2024. The importance of equity in payments to encourage coexistence with large mammals. Conserv. Biol. 38 (3), e14207.

Hansen, I., Strand, G.H., De Boon, A., Sandström, C., 2019. Impacts of Norwegian large carnivore management strategy on national grazing sector. J. Mt. Sci. 16 (11), 2470–2483.
Hardalau, D., Codrean, C., Iordache, D., Fedorca, M., Ionescu, O., 2024. The expanding thread of ungulate browsing—A review of forest ecosystem effects and management approaches in Europe. Forests 15 (8), 1311.
Hardalau, D., Stefanescu, V., Bakševičius, M., Manton, M., Ruffner, C., Brazaitis, G., Ionescu, O., 2025. Bite by Bite: How Ungulate Browsing Shapes North America's Forest Future. Forests 16 (7), 1079.
Harihar, A., Pandav, B., Goyal, S.P., 2011. Responses of leopard Panthera pardus to the recovery of a tiger Panthera tigris population. J. Appl. Ecol. 48 (3), 806–814.
Haugen, J.F., Olaussen, J.O., 2025. Stakeholder perceptions of the Norwegian salmon farming industry and its future challenges. Ecol. Econ. 230, 108477.
Hayward, M.W., Kerley, G.I., 2009. Fencing for conservation: restriction of evolutionary potential or a riposte to threatening processes? Biol. Conserv. 142 (1), 1–13.
Heggberget, T.M., 1996. En kunnskapsoversikt for eurasiatisk oter Lutra lutra; grunnlag for en forvaltningsplan. NINA Oppdragsmeld. 439, 1–29.
Helldin, J.O., 2000. Population trends and harvest management of pine marten Martes martes in Scandinavia. Wildl. Biol. 6 (2), 111–120.
Hersoug, B., 2021. Why and how to regulate Norwegian salmon production?–The history of Maximum Allowable Biomass (MAB). Aquaculture 545, 737144.
Herzon, I., Mikk, M., 2007. Farmers' perceptions of biodiversity and their willingness to enhance it through agri-environment schemes: A comparative study from Estonia and Finland. J. Nat. Conserv. 15 (1), 10–25.
Hesthagen, T., Larsen, B.M., Fiske, P., 2011. Liming restores Atlantic salmon (Salmo salar) populations in acidified Norwegian rivers. Can. J. Fish. Aquat. Sci. 68 (2), 224–231. https://doi.org/10.1139/F10-133.
Hesthagen T., Wienerroither R., Bjelland O., Byrkjedal I., Fiske P., Lynghammar A., Nedreaas K. og Straube N. (24.11.2021). Fisker: Vurdering av laks Salmo salar for Norge. Rødlista for arter 2021. Artsdatabanken. ⟨https://www.artsdatabanken.no/lister/rodlisteforarter/2021/8149⟩.
Hilty, J.A., Chester, C.C., Wright, P.A., Zenkewich, K., 2024. Uniting hearts and lands: advancing conservation and restoration across the Yellowstone to Yukon region. Front. Conserv. Sci. 4, 1264460.
Hindar, K., Hole, L.R., Kausrud, K.L., Malmstrøm, M., Rimstad, E., Robertson, L., … & Velle, G. (2020). Assessment of the risk to Norwegian biodiversity and aquaculture from pink salmon (Oncorhynchus gorbuscha). Scientific opinion of the panel on alien organisms and trade in endangered species of the Norwegian scientific committee for food and environment.
Højberg, P.L., Nielsen, M.R., Jacobsen, J.B., 2016. Fear, economic consequences, hunting competition, and distrust of authorities determine preferences for illegal lethal actions against gray wolves (*Canis lupus*): a choice experiment among landowners in Jutland, Denmark. Crime. Law Soc. Change 67, 461–480. https://doi.org/10.1007/s10611-016-9670-2.
Houde, A.L.S., Fraser, D.J., Hutchings, J.A., 2010. Reduced anti-predator responses in multi-generational hybrids of farmed and wild Atlantic salmon (Salmo salar L.). Conserv. Genet. 11 (3), 785–794. https://doi.org/10.1007/s10592-009-9892-2.
ICES, 2021. Joint EIFAAC/ICES/GFCM working group on eels(WGEEL). ICES Sci. Rep. 3, 205. https://doi.org/10.17895/ices.pub.8143.
ilaks.no. (2024). Otere forsyner seg av ventemerdene til Leroy Aurora – bryr seg lite om at vi prøver å jage de bort. Retrieved from ⟨https://ilaks.no/otere-forsyner-seg-av-ventemerdene-til-leroy-aurora-bryr-seg-lite-om-at-vi-prover-a-jage-de-bort/⟩.
Jacobs, M.H., Vaske, J.J., Sijtsma, M.T., 2014. Predictive potential of wildlife value orientations for acceptability of management interventions. J. Nat. Conserv. 22 (4), 377–383.
Jepson, P.R., 2022. To capitalise on the Decade of Ecosystem Restoration, we need institutional redesign to empower advances in restoration ecology and rewilding. People Nat. 4 (6), 1404–1413.
Jiménez, J., Nuñez-Arjona, J.C., Mougeot, F., Ferreras, P., González, L.M., García-Domínguez, F., López-Bao, J.V., 2019. Restoring apex predators can reduce mesopredator abundances. Biol. Conserv. 238, 108234.
Jiménez-Franco, M.V., Graciá, E., Rodríguez-Caro, R.C., Anadón, J.D., Wiegand, T., Giménez, A., 2024. Alternative vegetation trajectories through passive habitat rewilding: opposite effects for animal conservation. Landsc. Ecol. 39 (4), 78.
Johnson, J.B., Belk, M.C., 2020. Predators as agents of selection and diversification. Diversity 12 (11), 415.
Jørgensen, D., 2015. Rethinking rewilding. Geoforum 65, 482–488.
Junge, X., Jacot, K.A., Bosshard, A., Lindemann-Matthies, P., 2009. Swiss people's attitudes towards field margins for biodiversity conservation. J. Nat. Conserv. 17 (3), 150–159. https://doi.org/10.1016/j.jnc.2008.12.004.
Keller, R., Zouhar, Y., Dressel, S., Anderson, O.,Sandström, C. (2022, Oct. 19-22). The Nordic View? Attitudes of Lethal Control and Perceptions of Wildlife in Norway and Sweden [conference presentation]. Pathways Europe 2022: Human Dimensions of Wildlife, Wagningen, Netherlands. ⟨https://www.wur.nl/pathways-europe-2022-human-dimensions-of-wildlife-conference-and-training.htm⟩.
Khoo, M.D.Y., Lee, B.H., 2020. The urban smooth-coated otters Lutrogale perspicillata of Singapore: a review of the reasons for success. Int. Zoo. Yearb. 54 (1), 60–71.
Kjoberg, I. 2023. The influence of re-establishing Eurasian otter (Lutra lutra) on the activity of invasive American mink (Neovison vison) on the southwest coast of Norway. Master thesis. The University of Bergen. Available from ⟨https://bora.uib.no/bora-xmlui/handle/11250/3072350⟩ (accessed July 10, 2023).
Klenke, R., Ring, I., Máñez, K.S., Habighorst, R., Weiss, V., Wittmer, H., Henle, K., 2013. Otters in Saxony: a story of successful conflict resolution. Hum. Wildl. Confl. Eur. Fish. Fish. Eat. Vertebr. a Model Case 107–140.
König, H.J., Ceaușu, S., Reed, M., Kendall, H., Hemminger, K., Reinke, H., Ford, A.T., 2021. Integrated framework for stakeholder participation: methods and tools for identifying and addressing human–wildlife conflicts. Conserv. Sci. Pract. 3 (3), e399.
Kortan, D., Adámek, Z., Vrána, P., 2010. Otter, Lutra lutra, feeding pattern in the Kamenice River (Czech Republic) with newly established Atlantic salmon, Salmo salar, population. Folia Zool. 59 (3), 223–230.
Krange, O., Skogen, K., & Helland, H. (2017). Nordmenns holdninger til store rovdyr-endringer fra 2010 til 2017.
Krange, O., Tangeland, T., Sandström, C., & Ericsson, G. (2012). Holdninger til store rovdyr i Norge og Sverige. *En komparativ studie av holdninger til rovdyr og rovviltforvaltning [Attitudes towards large carnivores in Norway and Sweden: A comparative study]. NINA Rapport*, *879*.
Krange, O., Von Essen, E., Skogen, K., 2022. Law abiding citizens: on popular support for the illegal killing of wolves. Nat. Cult. 17 (2), 191–214.
Kranz, A., 2000. Otters (Lutra lutra) increasing in Central Europe: from the threat of extinction to locally perceived overpopulation? Mamm 64 (4), 357–368. https://doi.org/10.1515/mamm.2000.64.4.357.
Krumm, C.E., Conner, M.M., Hobbs, N.T., Hunter, D.O., Miller, M.W., 2010. Mountain lions prey selectively on prion-infected mule deer. Biol. Lett. 6 (2), 209–211.
Kruuk, H., 2006. Otters: Ecology, Behaviour and Conservation. OUP Oxford.
Kruuk, H., 2014. Otters and eels: long-term observations on declines in Scotland. IUCN Otter Spec. Group Bull. 31 (1), 3–11.
Kuijper, D.P., Diserens, T.A., Say-Sallaz, E., Kasper, K., Szafrańska, P.A., Szewczyk, M., Churski, M., 2024. Wolves recolonize novel ecosystems leading to novel interactions. J. Appl. Ecol. 61 (5), 906–921.
Kurekova, M., 1999. Otters and fisheries-workshop report IUCN otter spec. Group Bull. 16 (1), 26–32.
kyst.no. (2025). Oter herjet i merdene – nå får Mowi felle den. Retrieved from ⟨https://www.kyst.no/mowi-mowi-feed-oter/oter-herjet-i-merdene-na-far-mowi-felle-den/1927840⟩.
Lalleroni, A., Quenette, P.Y., Daufresne, T., Pellerin, M., Baltzinger, C., 2017. Exploring the potential of brown bear (Ursus arctos arctos) as a long-distance seed disperser: a pilot study in South-Western Europe. Mammalia 81 (1), 1–9.
Lamb, C.T., Dubman, E., McNay, R.S., Giguere, L., Majchrzak, Y., Thacker, C., Ford, A.T., 2024. Assessing the health-fitness dynamics of endangered mountain caribou and the influence of maternal penning. Can. J. Zool. 102 (8), 673–690.
Landa, A., Guidos, S., 2020. Bycatch in local fishery disrupts natural reestablishment of Eurasian otter in western Norway. Conserv. Sci. Pract. 2 (7), e208. https://doi.org/10.1111/csp2.208.
Larson, S.D., Hoyt, Z.N., Eckert, G.L., Gill, V.A., 2013. Impacts of sea otter (Enhydra lutris) predation on commercially important sea cucumbers (Parastichopus californicus) in southeast Alaska. Can. J. Fish. Aquat. Sci. 70 (10), 1498–1507.
Layton-Matthews, K., Erikstad, K. E., Reiertsen, T. K., Anker-Nilssen, T., Barrett, R. T., Bringsvor, I. S., .. & Systad, G. H. (2024). Demographic causes of seabird population changes in Norway-Results from a large-scale analysis of demographic time series data.

LeBlanc, F. (2003). Protecting fish farms from predation by the Eurasian otter (Lutra lutra) in the Limousin region of central France: First results. OTTER SPECIALIST GROUP BULLETIN. 〈https://iucnosgbull.org/Volume20/Volume20_Issue1.pdf#page=31〉.
Lee, C., Luan, X., 2025. A review on eurasian otters in urban areas: principles for the enhancement of biodiversity. Diversity 17 (5), 356.
Lennox, R.J., Gallagher, A.J., Ritchie, E.G., Cooke, S.J., 2018. Evaluating the efficacy of predator removal in a conflict-prone world. Biol. Conserv. 224, 277–289. https://doi.org/10.1016/j.biocon.2018.05.003.
Lennox, R.J., Kambestad, M., Berhe, S., Birnie-Gauvin, K., Cooke, S.J., Dahlmo, L.S., Eldøy, S.H., Davidsen, J.G., Hanssen, E.M., Sortland, L.K., Shea, D., Nilsen, C.I., Skoglund, H., Velle, G., Hellström, G., Lundberg, P., Junge, C., Ferter, K., Wiik Vollset, K., 2025. The role of habitat in predator–prey dynamics with applications to restoration. Restor. Ecol. 33, e14354. https://doi.org/10.1111/rec.14354.
Leo, V., Reading, R.P., Gordon, C., Letnic, M., 2019. Apex predator suppression is linked to restructuring of ecosystems via multiple ecological pathways. Oikos 128 (5), 630–639.
Letty, J., Marchandeau, S., Aubineau, J., 2007. Problems encountered by individuals in animal translocations: lessons from field studies. Ecoscience 14 (4), 420–431.
Linnell, J.D.C., Aanes, R., Swenson, J.E., Odden, J., Linnell, J.D.C., 1997. Translocation of carnivores as a method for managing problem animals: a review. Biodivers. Conserv. 6 (9), 1245–1257. https://doi.org/10.1023/B:BIOC.0000034011.05412.cd.
Liu, Y., Bailey, J.L., Davidsen, J.G., 2019. Social-cultural ecosystem services of sea trout recreational fishing in Norway. Front. Mar. Sci. 6, 178.
Lõhmus, A., Leivits, M., Pēterhofs, E., Zizas, R., Hofmanis, H., Ojaste, I., Kurlavičius, P., 2017. The Capercaillie (Tetrao urogallus): an iconic focal species for knowledge-based integrative management and conservation of Baltic forests. Biodivers. Conserv. 26 (1), 1–21. https://doi.org/10.1007/s10531-016-1223-6.
Løkeland, M. (2023). "La oteren leve i Orkla". Naturvernforbundet. Retrieved from 〈https://naturvernforbundet.no/trondelag/la-oteren-leve-i-orkla/〉.
MacDonald, A.J., FitzSimmons, N.N., Chambers, B., Renfree, M.B., Sarre, S.D., 2014. Sex-linked and autosomal microsatellites provide new insights into island populations of the tammar wallaby. Heredity 112 (3), 333–342.
MacPherson, J., Wright, P., 2021. Long-term strategic recovery plan for pine martens in Britain. Vincent. Wildl. Trust 72.
Manfredo, M.J., Berl, R.E., Teel, T.L., Bruskotter, J.T., 2021. Bringing social values to wildlife conservation decisions. Front. Ecol. Environ. 19 (6), 355–362.
Manfredo, M.J., Teel, T.L., Dietsch, A.M., 2016. Implications of human value shift and persistence for biodiversity conservation. Conserv. Biol. 30 (2), 287–296. https://doi.org/10.1111/cobi.12619.
Manfredo, M.J., Teel, T.L., Simmons, B.A., Dressel, S., Glikman, J.A., Roy, S., Smith, D., & Sandström, C. (2022). Social values are crucial for monitoring trends in human-wildlife conflict. Policy Brief 12/2022. Colorado State University.
Marshall, K., White, R., Fischer, A., 2007. Conflicts between humans over wildlife management: on the diversity of stakeholder attitudes and implications for conflict management. Biodivers. Conserv. 16 (11), 3129–3146.
McDonald, R.A., O'Hara, K., Morrish, D.J., 2007. Decline of invasive alien mink (Mustela vison) is concurrent with recovery of native otters (Lutra lutra): Rising otter, fallen mink. Divers. Distrib. 13 (1), 92–98. https://doi.org/10.1111/j.1366-9516.2006.00303.x.
Metcalf, A.L., Metcalf, E.C., Brenner, L.J., Nesbitt, H.K., Phelan, C.N., Lewis, M.S., Gude, J.A., 2025. The wildlife attitude-acceptability framework's potential to inform human dimensions of wildlife science and practice. Hum. Dimens. Wildl. 30 (4), 415–429.
Mock, K.E., Latch, E.K., Rhodes, O.E., 2004. Assessing losses of genetic diversity due to translocation: long-term case histories in Merriam's turkey (Meleagris gallopavo merriami). Conserv. Genet. 5 (5), 631–645. https://doi.org/10.1007/s10592-004-1849-x.
Mollett, S., Wheeler, I., Asay, B., Holbrook, J., Furland, T., Manire, H., Dunning, K.H., 2025. Delisting the Grizzly bear from the Endangered Species Act: shifting politics and political discourse in the Greater Yellowstone Ecosystem. Front. Conserv. Sci. 6, 1508158.
Morel, L., Barbe, L., Jung, V., Clément, B., Schnitzler, A., Ysnel, F., 2020. Passive rewilding may (also) restore phylogenetically rich and functionally resilient forest plant communities. Ecol. Appl. 30 (1), e02007.
Mukesh, Sharma, L.K., Charoo, S.A., Sathyakumar, S., 2015. Conflict bear translocation: investigating population genetics and fate of bear translocation in Dachigam National Park, Jammu and Kashmir, India. PLoS One 10 (8), e0132005.
Nelson, H.V., Farquharson, K.A., Georges, A., McLennan, E.A., DeGabriel, J.L., Giese, M., Hogg, C.J., 2024. A genomic framework to assist conservation breeding and translocation success: a case study of a critically endangered turtle. Conserv. Sci. Pract. 6 (10), e13204.
Netz, C., Hildenbrandt, H., Weissing, F.J., 2022. Complex eco-evolutionary dynamics induced by the coevolution of predator–prey movement strategies. Evolut. Ecol. 36 (1), 1–17.
Newediuk, L., Richardson, E.S., Bohart, A.M., Roberto-Charron, A., Garroway, C.J., Jones, M.J., 2025. Designing epigenetic clocks for wildlife research. Mol. Ecol. Resour., e14120
Noble, M.M., Harasti, D., Fulton, C.J., Doran, B., 2020. Identifying spatial conservation priorities using Traditional and Local Ecological Knowledge of iconic marine species and ecosystem threats. Biol. Conserv. 249, 108709. https://doi.org/10.1016/j.biocon.2020.108709.
NOF avd Nordland. (2019). Otters in Norway: Impact on bird populations and conservation strategies. BirdLife Norge. Retrieved from 〈https://www.birdlife.no/organisasjonen/fylkesavdelinger/nordland/nyheter/?id=2311〉.
Nyhus, P.J., Fisher, H., Osofsky, S., Madden, F., 2003. Taking the bite out of wildlife damage: the challenges of wildlife compensation schemes. Conserv. Mag. (Former. Conserv. Pract.) 37.
Odden, J., Herfindal, I., Linnell, J.D.C., Andersen, R., 2008. Vulnerability of domestic sheep to lynx depredation in relation to roe deer density. J. Wildl. Manag. 72 (1), 276–282. https://doi.org/10.2193/2005-537.
Olaussen, J.O., 2018. Environmental problems and regulation in the aquaculture industry. Insights Nor. Mar. Policy 98, 158–163.
Ottersen, G., and Auran, J.A. (2007). Helhetlig forvaltningsplan for Norskehavet: Arealrapport med miljø-og naturressursbeskrivelse. 〈https://imr.brage.unit.no/imr-xmlui/handle/11250/112875〉.
Parker, H., Rosell, F., Mysterud, A., 2007. Harvesting of males delays female breeding in a socially monogamous mammal; the beaver. Biol. Lett. 3 (1), 107–109. https://doi.org/10.1098/rsbl.2006.0563.
Parrish, D.L., Behnke, R.J., Gephard, S.R., McCormick, S.D., Reeves, G.H., 1998. Why aren't there more Atlantic salmon (Salmo salar)? Can. J. Fish. Aquat. Sci. 55 (S1), 281–287. https://doi.org/10.1139/d98-012.
Peebles, K.A., Wielgus, R.B., Maletzke, B.T., Swanson, M.E., 2013. Effects of remedial sport hunting on cougar complaints and livestock depredations. PLoS One 8 (11), e79713.
Pereira, H.M., Navarro, L.M., 2015. Rewilding European Landscapes. Springer Nature, p. 227.
Pérez-González, J., Carranza, J., Anaya, G., Broggini, C., Vedel, G., de la Peña, E., Membrillo, A., 2023. Comparative analysis of microsatellite and SNP markers for genetic management of red deer. Animals 13 (21), 3374.
Perino, A., Pereira, H.M., Navarro, L.M., Fernández, N., Bullock, J.M., Ceaușu, S., Wheeler, H.C., 2019. Rewilding complex ecosystems. Science 364 (6438), eaav5570.
Pooley, S., Bhatia, S., Vasava, A., 2021. Rethinking the study of human–wildlife coexistence. Conserv. Biol. 35 (3), 784–793.
Prior, J., Brady, E., 2017. Environmental aesthetics and rewilding. Environ. Values 26 (1), 31–51.
Quaglietta, L., Fusillo, R., Marcelli, M., Loy, A., Boitani, L., 2019. First telemetry data on wild individuals from the threatened, isolated Italian otter (Lutra lutra) population. Mammalia 83 (5), 447–452. https://doi.org/10.1515/mammalia-2017-0157.
Quaglietta, L., Hájková, P., Mira, A., Boitani, L., 2015. Eurasian otter (Lutra lutra) density estimate based on radio tracking and other data sources. Mammal. Res. 60 (2), 127–137. https://doi.org/10.1007/s13364-015-0216-2.
Ratajczak, Z., Carpenter, S.R., Ives, A.R., Kucharik, C.J., Ramiadantsoa, T., Stegner, M.A., Turner, M.G., 2018. Abrupt change in ecological systems: inference and diagnosis. Trends Ecol. Evol. 33 (7), 513–526.
Reed, M.S., 2008. Stakeholder participation for environmental management: a literature review. Biol. Conserv. 141 (10), 2417–2431.
Reid, N., Thompson, D., Hayden, B., Marnell, F., Montgomery, W.I., 2013. Review and quantitative meta-analysis of diet suggests the Eurasian otter (Lutra lutra) is likely to be a poor bioindicator. Ecol. Indic. 26, 5–13.
Richardson, S., Mill, A.C., Davis, D., Jam, D., Ward, A.I., 2020. A systematic review of adaptive wildlife management for the control of invasive, non-native mammals, and other human–wildlife conflicts. Mammal. Rev. 50 (2), 147–156.

Rigg, R., Finďo, S., Wechselberger, M., Gorman, M.L., Sillero-Zubiri, C., Macdonald, D.W., 2011. Mitigating carnivore–livestock conflict in. Eur. Lessons Slovak. Oryx 45 (2), 272–280.
Ripple, W.J., Beschta, R.L., 2012. Trophic cascades in Yellowstone: the first 15 years after wolf reintroduction. Biol. Conserv. 145 (1), 205–213.
Ripple, W.J., Beschta, R.L., Wolf, C., Painter, L.E., Wirsing, A.J., 2025. The strength of the Yellowstone trophic cascade after wolf reintroduction. Glob. Ecol. Conserv. 58, e03428.
Ripple, W.J., Estes, J.A., Beschta, R.L., Wilmers, C.C., Ritchie, E.G., Hebblewhite, M., Wirsing, A.J., 2014. Status and ecological effects of the world's largest carnivores. Science 343 (6167), 1241484.
Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a general theory of planning. Policy Sci. 4 (2), 155–169.
Rodriguez-Recio, M., Wikenros, C., Zimmermann, B., Sand, H., 2022. Rewilding by wolf recolonisation, consequences for ungulate populations and game hunting. Biology 11 (2), 317.
Rosell, F., Kavli Lodberg-Holm, H., Robstad, C., Ekeli, J., Kambestad, M., Lennox, R.J., Wiik Vollset, K. and Mohr Mortensen, R. (2021). Acceleration code for different behaviours in a Eurasian otter (Lutra lutra): a case study from the Bergen Aquarium. Report Universitetet i Sør-Øst Norge.
Sandlund, O.T., Berntsen, H.H., Fiske, P., Kuusela, J., Muladal, R., Niemelä, E., Zubchenko, A.V., 2019. Pink salmon in Norway: the reluctant invader. Biol. Invasions 21 (4), 1033–1054.
Sarmento, P., Bandeira, V., Gomes, P., Carrapato, C., Eira, C., Fonseca, C., 2021. Adapt or perish: how the Iberian lynx reintroduction affects fox abundance and behaviour. Hystrix 32 (1), 48.
Scheuerl, T., Cairns, J., Becks, L., Hiltunen, T., 2019. Predator coevolution and prey trait variability determine species coexistence. Proc. R. Soc. B 286 (1902), 20190245.
Schultz, P.W., Zelezny, L., 2003. Reframing Environmental Messages to be Congruent with American Values. Hum. Ecol. Rev. 10 (2), 126–136.
Sittenthaler, M., Bayerl, H., Unfer, G., Kuehn, R., Parz-Gollner, R., 2015. Impact of fish stocking on Eurasian otter (Lutra lutra) densities: a case study on two salmonid streams. Mamm. Biol. 80 (2), 106–113. https://doi.org/10.1016/j.mambio.2015.01.004.
Skogen, K., Mauz, I., Krange, O., 2008. Cry Wolf!: narratives of wolf recovery in France and Norway. Rural Sociol. 73 (1), 105–133. https://doi.org/10.1526/003601108783575916.
Slobodkin, L.B., 1968. How to be a predator. Am. Zool. 8, 43–51.
Smith, M.E., Linnell, J.D.C., Odden, J., Swenson, J.E., 2010. Review of Methods to Reduce Livestock Depredation II. Aversive conditioning, deterrents and repellents. Acta Agric. Scand. Sect. A Anim. Sci. 50 (4), 304–315. https://doi.org/10.1080/090647000750069502.
Smolko, P., Kubala, J., Klinga, P., Lebocký, T., Kropil, R., Zbranek, J., Svitok, M., 2025. From conflict to conservation: understanding public attitudes of hunters and conservationists toward Carpathian lynx (Lynx lynx carpathicus) in Slovakia. Conserv. Sci. Pract., e70072
Solberg, M.F., Robertsen, G., Sundt-Hansen, L.E., Hindar, K., Glover, K.A., 2020. Domestication leads to increased predation susceptibility. Sci. Rep. 10 (1), 1929.
Solberg, M.N., & Rønning, O. (2019). "Frykter mink tar over dersom det åpnes for jakt på oter". NRK. Retrieved from ⟨https://www.nrk.no/nordland/frykter-mink-tar-over-dersom-det-apnes-for-jakt-pa-oter-1.14520552⟩.
Sortland, L.K., Lennox, R.J., Velle, G., Vollset, K.W., Kambestad, M., 2023. Impacts of predation by Eurasian otters on Atlantic salmon in two Norwegian rivers. Freshw. Biol. 68 (7), 1176–1193.
Soule, M., Noss, R., 1998. Rewilding and biodiversity: complementary goals for continental conservation. Wild Earth 8, 18–28.
Speed, J.D., Austrheim, G., Kolstad, A.L., Solberg, E.J., 2019. Long-term changes in northern large-herbivore communities reveal differential rewilding rates in space and time. PloS One 14 (5), e0217166.
Sperry, R.C., Jetter, A.J., 2019. A systems approach to project stakeholder management: fuzzy cognitive map modeling. Proj. Manag. J. 50 (6), 699–715.
Sponarski, C.C., Vaske, J.J., Bath, A.J., 2015. The role of cognitions and emotions in human–coyote interactions. Hum. Dimens. Wildl. 20 (3), 238–254. https://doi.org/10.1080/10871209.2015.1010756.
Stahl, P., Vandel, J.M., Herrenschmidt, V., Migot, P., 2001. Predation on livestock by an expanding reintroduced lynx population: long-term trend and spatial variability. J. Appl. Ecol. 38 (3), 674–687.
Stepien, E.N., Galatius, A., Hansen, K.A., Nabe-Nielsen, J., Teilmann, J., Wahlberg, M., 2024. Response of Eurasian otters (Lutra lutra) to underwater acoustic harassment device sounds. Sci. Rep. 14 (1), 4988.
Stien, J., Ims, R.A., & Yoccoz, N.G. (2011). Invasive American Mink (Neovison vison): Status, Ecology and Control Strategies. Scientific Basis for Action Plan Against American Mink in Norway.
Stokke, B.G., Dale, S., Jacobsen, K.-O., Lislevand, T., Solvang, R., and Strøm, H. (2021b). Fugler: Vurdering av ærfugl Somateria mollissima for Norge. Rødlista for arter 2021. Artsdatabanken. Available: ⟨https://www.artsdatabanken.no/lister/rodlisteforarter/2021/27698⟩.
Straka, T.M., Miller, K.K., Jacobs, M.H., 2020. Understanding the acceptability of wolf management actions: roles of cognition and emotion. Hum. Dimens. Wildl. 25 (1), 33–46.
Streeting, L.M., Dillon, M.L., Nesbitt, J., Nesbitt, B., Baker, L., Spark, P.H., Bower, D.S., 2023. A shocking result—Electric fences protect western saw-shelled turtle (Myuchelys bellii) nests from depredation by foxes. Austral Ecol. 48 (8), 1571–1587.
Svenning, J.C., Buitenwerf, R., Le Roux, E., 2024. Trophic rewilding as a restoration approach under emerging novel biosphere conditions. Curr. Biol. 34 (9), R435–R451.
Svenning, J.C., Pedersen, P.B., Donlan, C.J., Ejrnæs, R., Faurby, S., Galetti, M., Vera, F.W., 2016. Science for a wilder Anthropocene: synthesis and future directions for trophic rewilding research. Proc. Natl. Acad. Sci. 113 (4), 898–906.
Swan, G.J., Redpath, S.M., Bearhop, S., McDonald, R.A., 2017. Ecology of problem individuals and the efficacy of selective wildlife management. Trends Ecol. Evol. 32 (7), 518–530.
Taastrøm, H.M., Jacobsen, L., 1999. The diet of otters (Lutra lutra L.) in Danish freshwater habitats: comparisons of prey fish populations. J. Zool. 248 (1), 1–13.
Tamario, C., Calles, O., Watz, J., Nilsson, P.A., Degerman, E., 2019. Coastal river connectivity and the distribution of ascending juvenile European eel (Anguilla anguilla L.): Implications for conservation strategies regarding fish-passage solutions. Aquat. Conserv. Mar. Freshw. Ecosyst. 29 (4), 612–622.
Tandberg A.H.S., Djursvoll P., Falkenhaug T., Glenner H., Meland K. og Walseng B. (24.11.2021). Krepsdyr: Vurdering av edelkreps Astacus astacus for Norge. Rødlista for arter 2021. Artsdatabanken. ⟨https://lister.artsdatabanken.no/rodlisteforarter/2021/4463⟩. Nedlastet 18.06.2025.
Tanguay, L., Bissonnette, J.F., Turgeon, K., Calmé, S., 2021. Intervention levers for increasing social acceptance of conservation measures on private land: a systematic literature review and comprehensive typology. Environ. Res. Lett. 16 (7), 073007.
Teel, T.L., Adams, M., Carlos, A.W.D., Bonnell, M.A., Breck, S.W., 2022. A mixed-methods social psychology application evaluating the role of citizen science in mitigating human-wildlife conflict. Soc. Anim. 1 (aop), 1–24. https://doi.org/10.1163/15685306-bja10067.
The Norwegian Scientific Advisory Committee for Atlantic Salmon, 2025. Status for norske laksebestander i 2025. Rapport fra Vitenskapelig råd for lakseforvaltning nr 21.
Tosi, G., Chirichella, R., Zibordi, F., Mustoni, A., Giovannini, R., Groff, C., Apollonio, M., 2015. Brown bear reintroduction in the Southern Alps: to what extent are expectations being met? J. Nat. Conserv. 26, 9–19.
Treves, A., 2009. Hunting for large carnivore conservation. J. Appl. Ecol. 46 (6), 1350–1356.
Treves, A., Jurewicz, R.R., Naughton-Treves, L., Rose, R.A., Willging, R.C., Wydeven, A.P., 2002. Wolf depredation on domestic animals in Wisconsin, 1976-2000. Wildl. Soc. Bull. 231–241.
Tuckett, Q.M., Deacon, A.E., Fraser, D., Lyons, T.J., Lawson, K.M., Hill, J.E., 2021. Unstable intraguild predation causes establishment failure of a globally invasive species. Ecology 102 (8), e03411.
Ulanowicz, R.E., Holt, R.D., Barfield, M., 2014. Limits on ecosystem trophic complexity: insights from ecological network analysis. Ecol. Lett. 17 (2), 127–136.
Václavíková, M., Václavík, T., Kostkan, V., 2011. Otters vs. fishermen: stakeholders' perceptions of otter predation and damage compensation in the Czech Republic. J. Nat. Conserv. 19 (2), 95–102. https://doi.org/10.1016/j.jnc.2010.07.001.

Van Dijk, J., Kambestad, M., Carss, D.C., and Hamre, Ø. (2020). Kartlegging av oterens effekt på bestander av laks og sjøørret-Sunnmøre. ⟨https://brage.nina.no/nina-xmlui/handle/11250/2650751?locale-attribute=no⟩.
Van Dijk, J., May, R., Hamre, Ø. & Solem, M.I. (2016). Kartlegging av oterfallvilt for perioden 2011-2015 og verifisering av otertilstedeværelse i ulike deler av Norge. NINA Rapport 1229. 32 s.
Van Dijk, J., Rød-Eriksen, L., Hamre, Ø., and May, R. (2021). Kartlegging av oterfallvilt, oppdatering av otertetthetsindeks, og kartlegging av oterforekomst i Norge 2016–2020. ⟨https://brage.nina.no/nina-xmlui/handle/11250/2729157?locale-attribute=no⟩.
Van Dijk, J. & Ulvund, K.R. 2018. Monitoring otter activity in the routing area for a new power cable. NINA Report 1533. Norwegian Institute for Nature Research.
Vogel, J.T., Somers, M.J., Venter, J.A., 2018. The foraging ecology of reintroduced African wild dog in small protected areas. Wildl. Biol. 2018 (1), 1–10.
Vollset, K.W., Urdal, K., Utne, K., Thorstad, E.B., Sægrov, H., Raunsgard, A., Skagseth, Ø., Lennox, R.J., Østborg, G.M., Ugedal, O., Jensen, A.J., Bolstad, G.H., Fiske, P., 2022. Ecological regime shift in the Northeast Atlantic Ocean revealed from the unprecedented reduction in marine growth of Atlantic salmon. Sci. Adv. 8 (2022), eabk2542. https://doi.org/10.1126/sciadv.abk2542.
White, P.C., Ward, A.I., 2010. Interdisciplinary approaches for the management of existing and emerging human–wildlife conflicts. Wildl. Res. 37 (8), 623–629.