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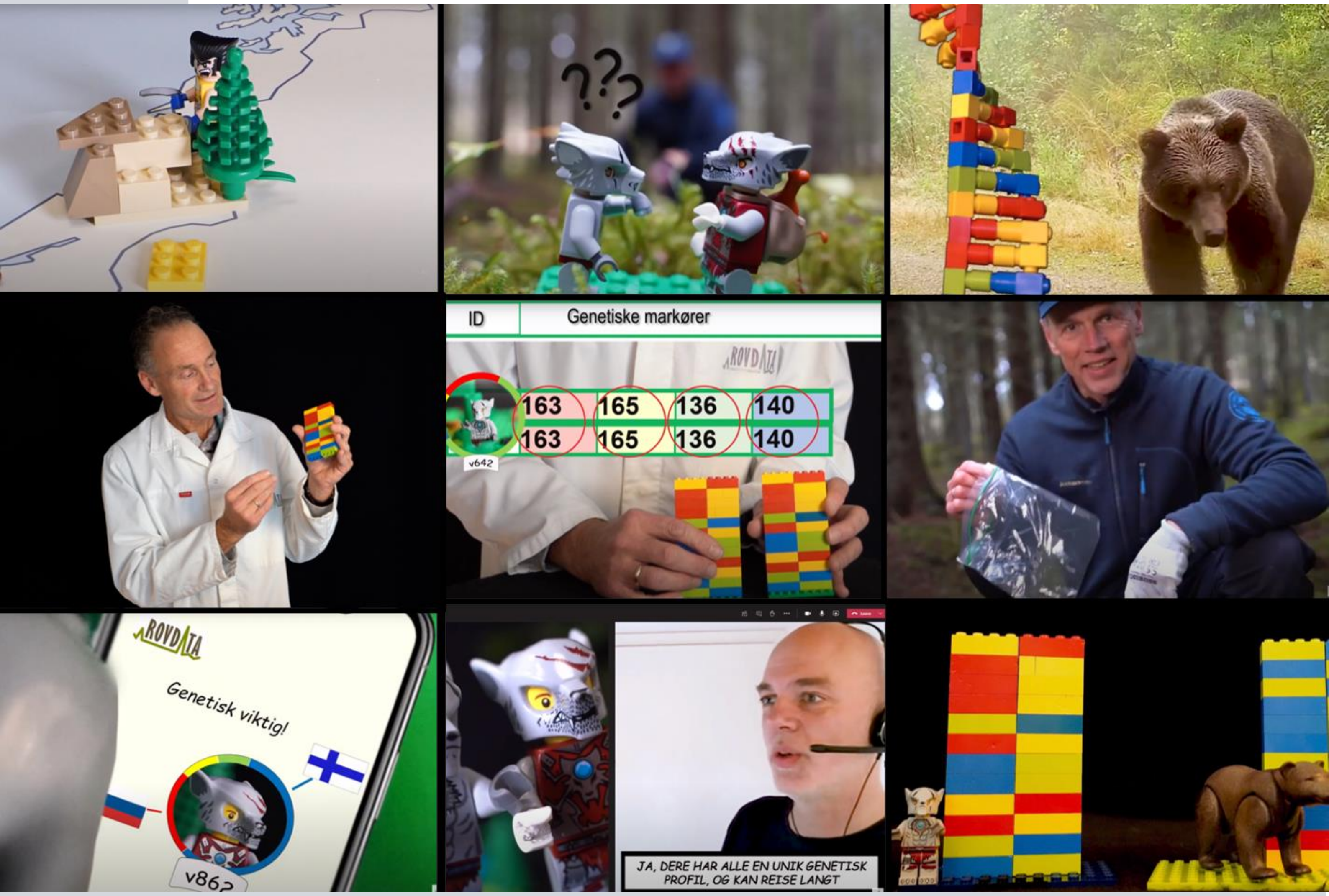
DNA-based monitoring of large carnivores in Scandinavia

– dissemination from a visual storyline approach

Alexander Kopatz, Juliet Landrø, Øystein Flagstad, Jan Arne Stokmo



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Alexander Kopatz
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Abstract

Kopatz, A., Landrø, J., Flagstad, Ø. & Stokmo, J.A.. 2021. DNA-based monitoring of large carnivores in Scandinavia – dissemination from a visual storyline approach. NINA Report 1999. Norwegian Institute for Nature Research.

In Norway, and also Scandinavia, non-invasive genetic tagging plays a fundamental role in wildlife monitoring to identify individual animals and their management. The development of this technology revolutionized how we monitor our natural environment today. Norwegian large carnivore professionals have worked with non-invasive genetic methods now for two decades and gained substantial experience as Norway is one of the few countries applying these methods annually and nationwide. Also, DNA-based techniques are evolving constantly and thus are becoming more and more important and are therefore increasingly implemented into wildlife and environmental monitoring. Despite this comparably long tradition of non-invasive genetic monitoring, there seem to be gaps in the knowledge and unawareness how large carnivores are monitored using these methods in our society. We suppose that there is unutilized potential in using popular media to inform and to educate the society. In line with this, we proposed a project to develop and produce a short movie explaining DNA-based monitoring of large carnivores to be distributed across social media and internet. The production had to take several hurdles in summarizing and explaining the often detailed and case-based interplay of science, management as well as political decisions. Hence, the production involved scientists, wildlife professionals and advisors from Norway. With publication of the movie, also additional material in form of StoryMaps, a press release and a podcast were published and can be used and shared by everyone, including schools, local and county administration and non-governmental organizations. The movie provides a short but comprehensive overview on the DNA-based monitoring of large carnivores in Norway, and we hope that it will serve as an important contribution to education and also the public debate. A visual story-line approach is unlikely to substitute established ways, to communicate monitoring and research results, however appears to be a valuable, and promising additional tool to engage larger and especially additional parts of public on the long-term, including an international audience.

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Sammendrag

Kopatz, A., Landrø, J., Flagstad, Ø. & Stokmo, J.A. 2021. DNA-basert overvåking av rovvilt i Skandinavia – en visuell formidlingsstrategi ved hjelp av video. NINA Rapport 1999. Norsk institutt for naturforskning.

Genetiske analyser av DNA-materiale fra ekskrementer, urin og hår - samlet inn i felt uten å forstyrre dyrene - er implementert som et viktig verktøy i rovviltovervåkingen i Skandinavia. Utviklingen av denne teknologien revolusjonerte måten vi overvåker vårt naturlige miljø på. Siden årtusenskiftet har eksperter på store rovdyr i Norge arbeidet med denne typen teknikker og bygget opp en betydelig erfaring. Norge er ett av få land som anvender disse metodene årlig og i hele landet, og gjennom kontinuerlig metodeutvikling blir DNA-analyser stadig viktigere i overvåkingsarbeidet. Det er fortsatt ikke alle som er bevisst eller som har innsikt i hvordan de store rovdyrene blir overvåket med disse metodene. Vi mener det er et ubenyttet potensiale knyttet til bruk av populærvitenskapelige framstillinger av denne typen forskning og overvåking via egnede medieplattformer. Med dette som utgangspunkt foreslo vi et prosjekt som skulle utvikle og produsere en kortfilm som forklarer DNA-basert overvåking av store rovdyr, og som kan deles på sosiale medier og internett. Den største utfordringen var å oppsummere og forklare det ofte detaljerte og saksorienterte samspillet mellom vitenskap, forvaltning og politiske beslutninger i en enkel fremstillingsform, forståelig for folk flest. Vi involverte derfor forskere, eksperter på rovvilt og rådgivere fra rovviltforvaltningen i Norge i produksjonen. Samtidig med publisering av filmen gav vi også ut tilleggsmateriell i form av en StoryMaps, en pressemelding og en podkast. Alt dette materialet kan brukes og deles av alle, inklusive skoler, lokal og regional forvaltning og interesseorganisasjoner. Filmen gir en kort, men omfattende oversikt over den DNA-baserte overvåkingen av store rovdyr i Norge, og vi håper at den vil være et viktig bidrag innenfor felt som utdanning og den offentlige debatten. En tilnærming med en visuell storyline vil trolig ikke erstatte mer tradisjonelle måter å kommunisere resultater fra overvåking og forskning, men denne typen formidling ser ut til å være et verdifullt og lovende ekstra verktøy for å engasjere større og spesielt andre deler av publikum på lang sikt, inklusive et internasjonalt publikum.

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Contents

Foreword

Inspired by the uniqueness and sophistication of non-invasive genetic tagging to monitor large carnivores in Norway, we set out to summarize and explain as simple as possible how DNA is used and what the benefits, but also what the challenges, are. Here we present a visual storyline approach to communicate science and to explain how DNA-based monitoring of large carnivores is applied in Norway and Scandinavia. Another objective was to raise awareness on the Norwegian Large Predator Monitoring Program and its comprehensive application of DNA-based methods.

Due to often detailed intertwinement of science (methodology and technology), administration (management and conflict resolution) and society (knowledge and acceptance) as well as politics (e.g. Convention of Biodiversity, Bern Convention etc.), conceptualization demanded substantial time and effort. The project is reflective of how science is applied to benefit society and species conservation. We hope the report is reflective of that, and we wanted to assure to present the rationale behind methodology, decision-making and also story-telling and style-choices made during the course of this project. We hope this report may be utilized to guide similar, follow-up or new projects on communicating elaborating scientific information to the public.

The project was funded by the Norwegian Environment Agency. The movie and additional products were produced by the Norwegian Institute for Nature Research and Rovdata. We are very grateful for the inspiration, input and constructive feedback provided by the experts from the Norwegian Environment Agency, Norwegian State Nature Inspectorate and IUCN Species Survival Commission Conservation Genetics Specialist Group during the creative process and realization of this project.

Trondheim, April 2021

Alexander Kopatz

1 Introduction

Non-invasive DNA-based monitoring for genetic identification, and individual molecular tagging of an organism by its unique genetic profile or DNA fingerprint, plays a fundamental role overall in wildlife and specifically in large carnivore population monitoring, conservation and management. The term non-invasive describes the fact that genetic analyses are based on DNA from biological samples of the target species, collected without trapping or getting into direct contact with the animal (Taberlet et al. 1999). Since their development in the 1990s, these methods have revolutionized how we monitor and study wildlife today. Genetic or DNA profiles of identified individuals allow us to track their movements, can provide an overview on their distribution and number of individuals in an area or country (see e.g. Taberlet et al. 1999, Schwartz et al. 2007). DNA-based wildlife monitoring has shown to be reliable and further the most promising, empirical tool for monitoring natural environments in the future (Laikre et al. 2020). Hence, DNA-based monitoring is and will be increasingly important for comprehensive assessments, status reporting as well as decision making and conflict mitigation during the management of large carnivores (see e.g. Lamb et al. 2019, Bischof et al. 2020, Kopatz et al. 2021).

For more than a decade the Norwegian large carnivores are monitored with non-invasive genetic methods. In Scandinavia, a six-digit number of samples have been collected by wildlife professionals, researchers and volunteers and analysed since then. The identified individuals and their location, including date and other additional information, is stored and accessible for the public in the Scandinavian monitoring database Rovbase (www.rovbase.no). Biological samples left by wolf (*Canis lupus*), wolverine (*Gulo gulo*), brown bear (*Ursus arctos*) and Eurasian lynx (*Lynx lynx*) to some degree, and also golden eagle (*Aquila chrysaetos*), are collected and subject to DNA analysis for individual identification of the animal (see e.g. Taberlet et al. 1999, Schwartz et al. 2007). In Norway, feces samples make up the largest part of biological material collected for DNA analysis, but also hairs, urine as well as feathers from golden eagle are collected. Not every sample results in a positive identification of the individual which left it behind. Despite its overall simplicity, the application of DNA-based methods to monitor species entail several challenges, which can be hurdled by adhering to the scientific method and rigorous quality control of all steps involved (see e.g. Taberlet et al. 1996 & 1999, Pompanon et al. 2005, Linacre et al. 2010). The success rate for positive DNA and identification of especially feces, hair and urine samples can vary due to different reasons. Such reasons include the time a sample is exposed to the environment and unstable weather conditions depending on annual seasons. In feces samples it is also possible to find remains of the animals diet which may interfere with the genetic analyses and their outcome. The actual collection method itself, and the storage of the specimen, can have influence on the results of the DNA analysis (see e.g. Flagstad et al. 1999, Lucchini et al. 2002, Murphy et al. 2003, Piggott 2004). Such negative results need to be explained better, as such may confuse sometimes because it is often assumed that the DNA-method works on all samples.

We clearly not only see the need for better informing the public, but especially doing so, repeatedly, using state-of-the-art, social media frequently used by the majority of society (**Figure 1**), as done previously on other natural and environmental topics and issues produced by the Norwegian Institute for Nature Research and their partners (**Figure 2**). Therefore, we proposed a project to produce a pedagogic movie in Norwegian for social media, accompanied by a campaign to promote and inform the public better on the everyday work and techniques of DNA-based large carnivore monitoring. In order laymen to better understand how the method works, how and why we apply it and what its benefits are, we wanted to address some important basics on the methodology and to explain in more detail, but understandable still, the basics and reality of DNA-based monitoring of large carnivores in Norway and Scandinavia.

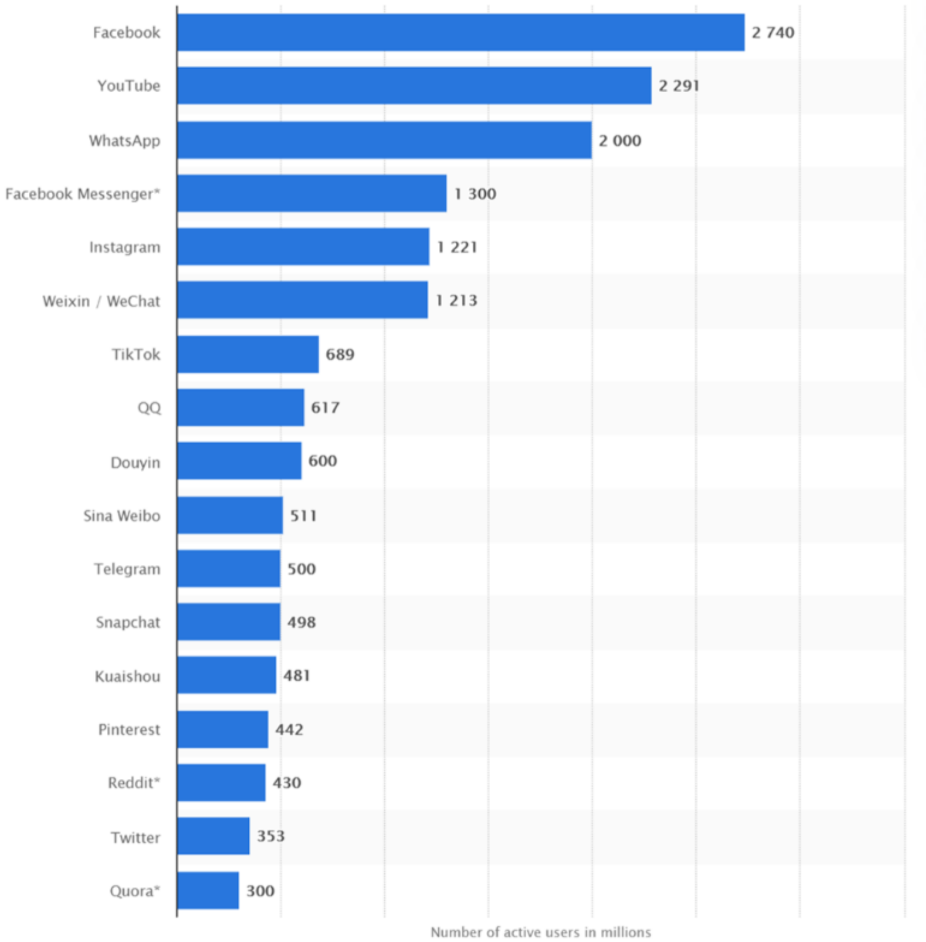


Figure 1*. Most popular social networks worldwide as of January 2021, ranked by number of active users (in millions). Source: Statista, https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/; *Platforms have not published updated user figures in the past 12 months, figures may be out of date and less reliable. © Statista 2021.*

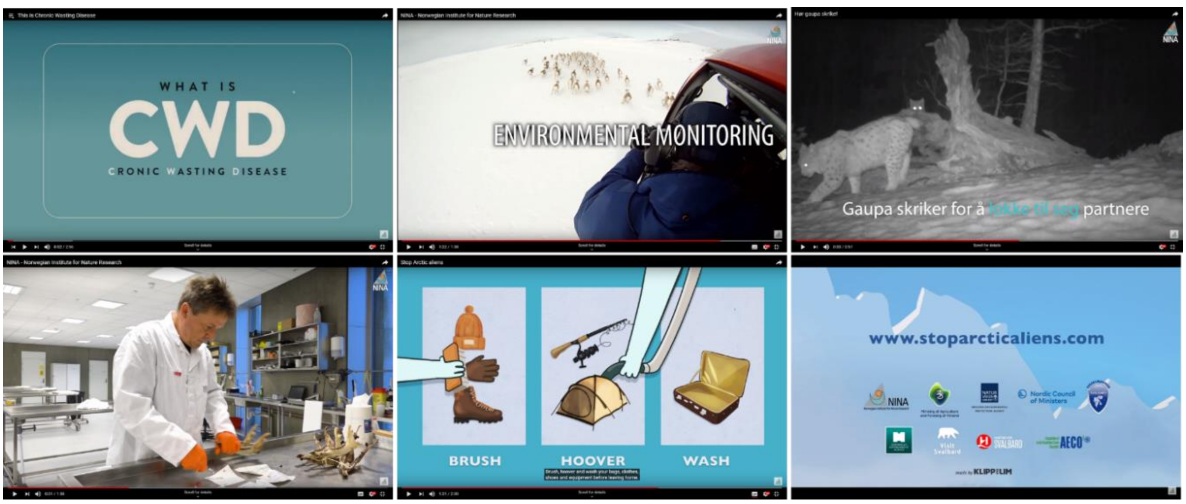


Figure 2*. Screencaps from different movies produced by NINA and published on NINA's YouTube-channel https://www.youtube.com/user/NINAforskning*

2 Objectives and target audience

The primary objective was to create a popular scientific media campaign around a 5-7 minutes pedagogic movie for YouTube and social media on the use of DNA for large carnivore monitoring, management and its relevance for our society to maintain and build up trust. The secondary objective was to raise awareness and attention, also internationally, and educate as well as promote the unique Norwegian large carnivore monitoring (**Figure 3**) to an international audience.

Our target audience was the general public. One of the basic goals was to be scientifically accurate while being as close as possible to people's, our audience's, reality. In that way we would be able to connect the relevance of DNA-based monitoring to people's life. However, large carnivores and their potential presence are not a regular part of every citizen's live and thus possibly not of highest relevance to everyone. Therefore, we also aimed to reach an audience, unaware of the current monitoring scheme. Another goal was to produce a movie with a possibly long lifetime. The planned movie had the following log line: *Humans and large carnivores co-exist in parts of Norway. Species monitoring and conflicts are often solved with the help of DNA-analyses to identify species and individual. Here we explain how that works, what the challenges are and what is the benefit for the people, society and animals.*

***Figure 3**. Species monitored under the Norwegian Large Predator Monitoring Program: Eurasian lynx, wolverine, brown bear, wolf and golden eagle.*

3 Approach and pre-production

Pre-production consisted of basically three elaborative parts (**Figure 4**): Brainstorming and collecting ideas (3.1), Defining the main issues to be addressed (3.2), and conceptualization and scripting the story and prepare filming (3.3). The core group of people of the production team were the authors of this report, two researchers and geneticists as well as two communication professionals; all having years of experience in their field of work and who met regularly during the course of this project. Other experts from Rovdata and the large carnivore monitoring, including Norwegian Environment Agency and Norwegian State Nature Inspectorate (SNO), were invited and joined the discussions.

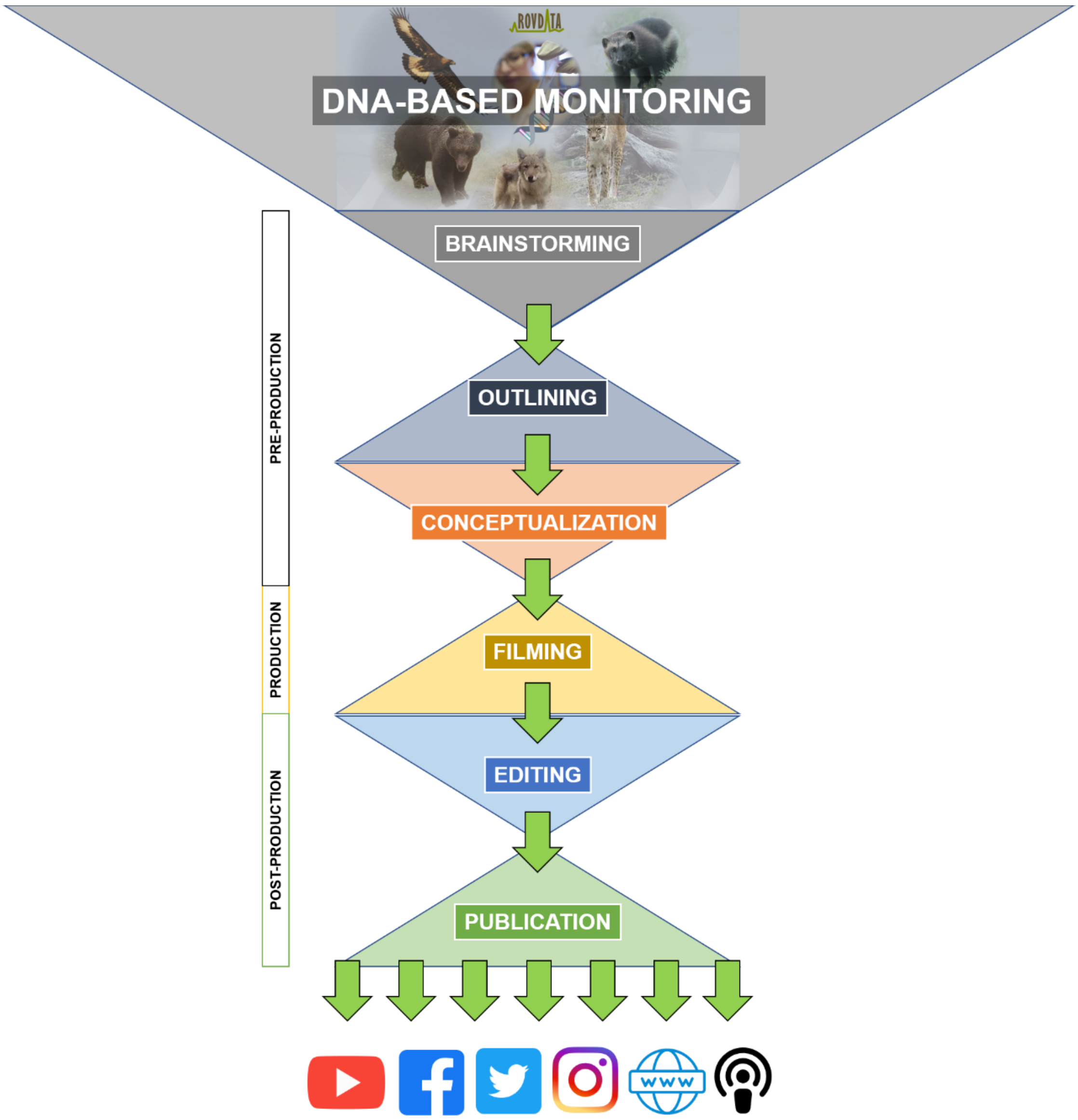


***Figure 4**. Flow-chart illustrating our approach and different stages of production.*

3.1 Brainstorming: compiling relevant content

First, we compiled a list of obvious and frequently posed questions or issues raised when it comes to DNA-based large carnivore monitoring and management (**Box I**). It became immediately clear that wolf monitoring and management is playing one, if not the most, prominent role in the debate in the media and public. The collection of questions was also to some parts inspired by the experience of researchers and managers abroad, with whom we are in regular contact. For instance, Carsten Nowak from the Conservation Genetics Section at the Senckenberg Research Institute and responsible for the DNA-based monitoring of wolves in Germany took part in an informative interview, facing the same challenges. In this interview, some of the main questions were addressed and important basics of the methods explained to the public (see: "*Im Epizentrum der Wolfsgenetik*", Wild & Hund 5, pages 14-23, in German).

***BOX I**. Compiled question on the DNA-based monitoring of large carnivores, and answered in the movie (✔) and podcast (✔).*

1. *Why are large carnivores monitored?* ✔
2. *Who benefits from this monitoring and research?* ✔
3. *What is DNA?* ✔
4. *Why is DNA used to monitor large carnivores and what is the benefit?* ✔
5. *What are the advantages of using DNA to monitor large carnivores?* ✔
6. *How does DNA-based monitoring is conducted in the field?* ✔
7. *What samples are used?* ✔
8. *What kind of samples are analysed?* ✔
9. *Where and when can such samples be found?*
10. *How does it work and what works best?*
11. *What is important to look out for?* ✔
12. *Who can I contact and ask questions when I have found what looks like a sample?* ✔
13. *What happens in the laboratory?* ✔
14. *How does one get the DNA out of a sample?* ✔
15. *What are the downsides of this method?*
16. *For what can we not use DNA for; what are potential drawbacks or problems?*
17. *What questions we cannot answer?*
18. *Who is responsible for the genetic analyses and results and why?* ✔
19. *DNA-based monitoring and its methods have been criticised; how do researchers respond to such critic?* ✔
20. *What are hybrid individuals and why is it important to identify them?* ✔
21. *When is a hybrid a hybrid?*
22. *Are there wolf-dog hybrids in Norway or the Scandinavian population?* ✔
23. *After centuries of co-existence there must have been crossings of wolves and dogs, right?* ✔
24. *One can read about wolf-dog hybrids found in other parts of the world, so it happens also here?*
25. *Are the indications or evidence that wolves have been intentionally released in Norway or Scandinavia?* ✔
26. *Are researchers confident that their reference samples are really pure wolves?* ✔
27. *How should we regulate the hunt on wolves?*
28. *What is a "genetically important" wolf?* ✔

3.2 Outlining: identifying and structuring the overarching questions

Second, we narrowed the field of questions down in preparation for our conceptual approach and a rough story board. In this step, we identified the most important, main questions and issues, which would allow us to outline their order and form a tentative narrative around DNA-based monitoring. We presented those, and how such a movie can be produced, to experienced personnel at the Norwegian Environment Agency and Norwegian State Nature Inspectorate. This was done to clarify and unify the overall message and that we have not forgotten any important questions or other aspects (**Figure 5**).

Figure 5*. First, rough storyboard summarizing the main issues and questions in regard to DNA-based large carnivore monitoring. Photo: Alexander Kopatz.*

3.3 Conceptualization: telling an engaging story

Third, once the main issues and questions were defined and agreed on, we sat down in a series of meetings to write the story around them. We wanted an engaging story most people may relate to, or – at least – may show interest in. As stated earlier, the target group was the general public. The overall challenge was that the discussion on DNA-based monitoring is multifaceted while being simultaneously highly detailed as well as often case-specific (**Table 2**; see e.g. the public debate in case of wolf translocations). While revisiting our initial outline from the application (**Figure 6**), it became clear that we did not want to follow a classical, chronological and stringent documentary format. Such a storyline was not considered dynamic and engaging enough for a broader audience. Instead, we looked for common features among videos that had successfully managed to engage viewers on YouTube and Facebook. Common among such successful videos were an engaging, surprising start or first scene, a good story with style & humour and interesting content. We had two main challenges during this step: 1. How do we explain DNA and genetic markers for individual identification in the simplest and possible most understandable way on screen; and especially suitable to be viewed on mobile devices? 2. Due to the rather complex interplay of numerous scientific, technical, methodological, biological, administrative but also socio-political aspects, what could be an engaging narrative keeping the viewer interested on the topic?

We entertained the idea of identifying a “lowest common denominator” to increase familiarity and to unify as many individuals in our audience as possible in our movie. Our choice fell onto one of the most widespread toys of our times, even among adults: LEGO. This toy likely exists in every Norwegian and Scandinavian household, and therefore most viewers will be familiar of its form, size and function. After initial tests, we believed that LEGO bricks would be a suitable, engaging (“build it yourself”) and well-known tool to explain what DNA is and how we use it in large carnivore monitoring. In hindsight it may look intuitive as both – DNA and LEGO – are built, or at least can be displayed, by “bricks”. Nonetheless, substantial effort still went into preparation on how to e.g. build a double-helix, a genetic or DNA-profile, how to show and explain different levels between animal, genome, genetic profile while keeping it simple and understandable, and how to film and frame it. The decision to use LEGO bricks also included to film stop-motion, at least in parts, to simulate motion. This opened for further possibilities and relieved us in investing in elaborate computer-assisted animations. LEGO allowed us to be as tactile and "hands-on" as possible.

Table 2*. Overview on DNA-based monitoring of large carnivores in Norway listing species, scale, sample material, genetic marker system and species specific particularities.*

		Brown bear	**Eurasian lynx**	**Golden eagle**	**Grey wolf**	**Wolverine**
		Ursus arctos	*Lynx lynx*	*Aquila chrysaetos*	*Canis lupus*	*Gulo gulo*
Monitoring	**Monitored**	✓	✓	✓	✓	✓
	Monitored with DNA	✓	✗	✓	✓	✓
	Nationally	✓	✓	✗	✓	✓
	Regionally	✗	✗	✓	✗	✗
Sample material	**Feces**	✓	✗	✗	✓	✓
	Urine	✗	✗	✗	✓	✓
	Secretion	✗	✗	✗	✗	✓
	Hairs	✓	✗	✗	✓	✓
	Feathers	✗	✗	✓	✗	✗
Genetic markers	**SNPs**	✗	✗	✓	✓	✓
	STRs	✓	✗	✗	✓	✓
!	**Particularity**	Denning during winter months			Maintenance of the pedigree Detection of im-migrants Detection of wolf-dog hybrids	

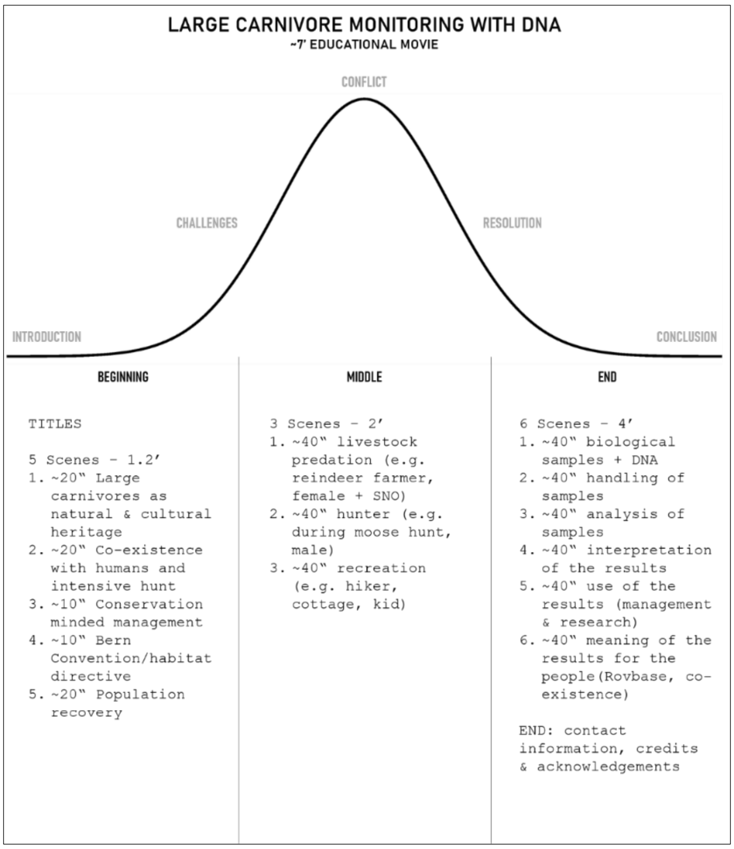


***Figure 6**: First, initial treatment of the proposed movie "Large Carnivore Monitoring with DNA".*

Our attempt was to be as general as possible. However, DNA-based monitoring across several species cannot be generalized without losing some of the important nitty-gritty, often specific for one or more large carnivore species (**Table 2**). Therefore, we decided to increase focus on wolves. For this species the harmonized Scandinavian monitoring led to a comprehensive database on DNA-profiles based on different genetic marker systems and a full pedigree. This would allow us to address all important aspects when it comes to show the benefits of DNA-based monitoring; including hybridization. By using LEGO wolves as the main characters we wanted them to be easily identifiable as wolves, however, also deliberately abstract them from real wolves. But we also wanted to make sure to represent the other large carnivore species. Therefore we addressed important issues and challenges which are relevant for all large carnivores, using brown bears or wolverine instead. We included e.g. the brown bear, where negative results of collected feces still poses an issue and hence is often brought up on discussions on how to improve the current monitoring scheme.

Besides fictional characters, we still wanted the important steps represented by having representatives and experts explaining their work and what is ultimately relevant for them. These would be field personnel, researcher and management administration. We further wanted to have another, uninvolved party to comment independently on the DNA-based monitoring and hence planned to include an international renowned expert. While the informative content was shaping up, we were still in need for an engaging, interacting story. We thought we needed a person or a protagonist guiding the viewer through the movie and "asking the questions" on behalf of the viewer. We rejected the idea of another, independent human protagonist as it may be perceived as too documentary-style. We created a story, inspired by real events, around a female wolf which meets a male wolf, who then questioning the DNA-based monitoring they just took part in with their feces (**Box II**).

***BOX II**. Large Carnivore monitoring with DNA*

The movie kicks-off with the two protagonists, a female and a male wolf meet for the first time. But just a moment before the female wolf meets another wolf, which turned out to be her father. Then she, philopatric, encounters another male wolf from Sweden. Their origin is underlined with the characters speaking in Norwegian and Swedish. This time she applies some care and points the male wolf, who obviously showed interest in her, that they probably should compare their DNA to make sure that they are also not related.

They watch a web video why DNA-based monitoring is important. Suddenly one of the wolves is picked up by a researcher. Bringing the main characters into the "real world", and introducing the mixed storyline between the ani-mated wolves and real researchers. The researcher and geneticist from Rovdata explains what DNA is and how it is used to identify individuals and their gender. At the end he points to a common challenge that DNA-profiles can remain incomplete. The researcher addresses the audience with the question of what could have happened here and the camera simultaneously switches to the field, where another expert, this time from the Norwegian State Nature Inspectorate (SNO), appears.

The experienced person from SNO explains what may have happened here, most likely that environmental conditions and their change have caused the degradation of the DNA molecule while the feces has been laying in the field. He continues highlighting the advantages of non-invasive genetic sampling, including that everyone can contribute in sample collection and that the results provide a comprehensive overview on the number of individuals and how they roam. The Swedish wolf, still a bit overwhelmed, asks why one wants to know all this?

At this point advisors from the Norwegian Environment Agency present the reasons for the DNA-based monitoring conducted in Norway. These contain the decision by the Norwegian Parliament and the usefulness of the DNA-method to identify individuals, including immigrating ones and genetically important wolves. Also here, the fact that large carnivore management engages people with opposite opinions is addressed.

The two wolves, now starting to get fascinated by the elaborate monitoring start to understand but would like to hear another opinion. They make a virtual call to an internationally renowned expert to ask her or his opinion. The call is then interrupted by a message that the results from their (the wolves') DNA-analyses are ready. The results show that the female wolf is related to the wolves in Scandinavia as she fits into the pedigree tree. The male wolf on the other hand is totally unrelated and his genetic signature is characteristic for wolves from Finland and Russia and is therefore considered as "genetically important".

In the final scene both wolves can let go and start to live together.

4 Production and filming

The Norwegian Institute for Nature Research (NINA) and its communication department is equipped with dedicated facilities and professional gear for the creation and realization of film and audio productions. Further, two members of the project's core team are communication professionals. In collaboration with the researchers as well as wildlife professionals associated and relevant to the objective, filming began in a dedicated studio at NINA's headquarter and also in the field (**Figure 7**).

Figure 7. *Test filming to identify the best location, ambience and environment and if the story works also on screen as well as behind-the-scene photos of the following filming and production. Photos: Jan Arne Stokmo and Alexander Kopatz.*

Based on our script (**Box II**) we filmed:

- Øystein Flagstad, geneticists and senior researcher at Rovdata, who explained DNA and how we use genetic information to monitor large carnivores.
- Tore Solstad, wildlife professional at the Norwegian State Nature Inspectorate, who explained what potential challenges in the field are, highlighting the benefits of using DNA.
- Elisa Keeling Hemphill and Siv Grethe Aarnes, wildlife professionals and advisors at the Norwegian Environment Agency, who explained why we monitor these species, what the benefits are and why DNA.
- Gernot Segelbacher, associate professor at the University of Freiburg and Co-chair of the IUCN Species Survival Commission Conservation Genetics Specialist Group, who

explained why the monitoring with DNA works well and acknowledging the achievements of the Norwegian Large Predator Monitoring Program.
- Stop-motion with LEGO, such as dialogues among the main protagonists, wolves, movement of animals across northern Europe, including a roaming wolverine, DNA double helix and DNA-profiles and the identification of genotypes with the database.
- B-roll and extra footage.

The raw material was edited and cut at NINA. Additional material from our archive, such as the footage from wildlife cameras, was added for better, illustrative explanation and flow. Preliminary versions of the movie, and also prior to its publication, the movie has been test-screened to different viewers, including children.

5 Publication and distribution

The movie premiered on February, 4th 2021 on YouTube: https://youtu.be/8J_DbzoA50c on NINA's channel. Since then it has been shared on NINA's and Rovdata's website, including a press release (see below) and social media, YouTube, Facebook, Twitter and Instagram (**Figure 8**); as well as by Miljødirektoratet's (Norwegian Environment Agency's) social media channels. Repeated postings and sharing occurred.

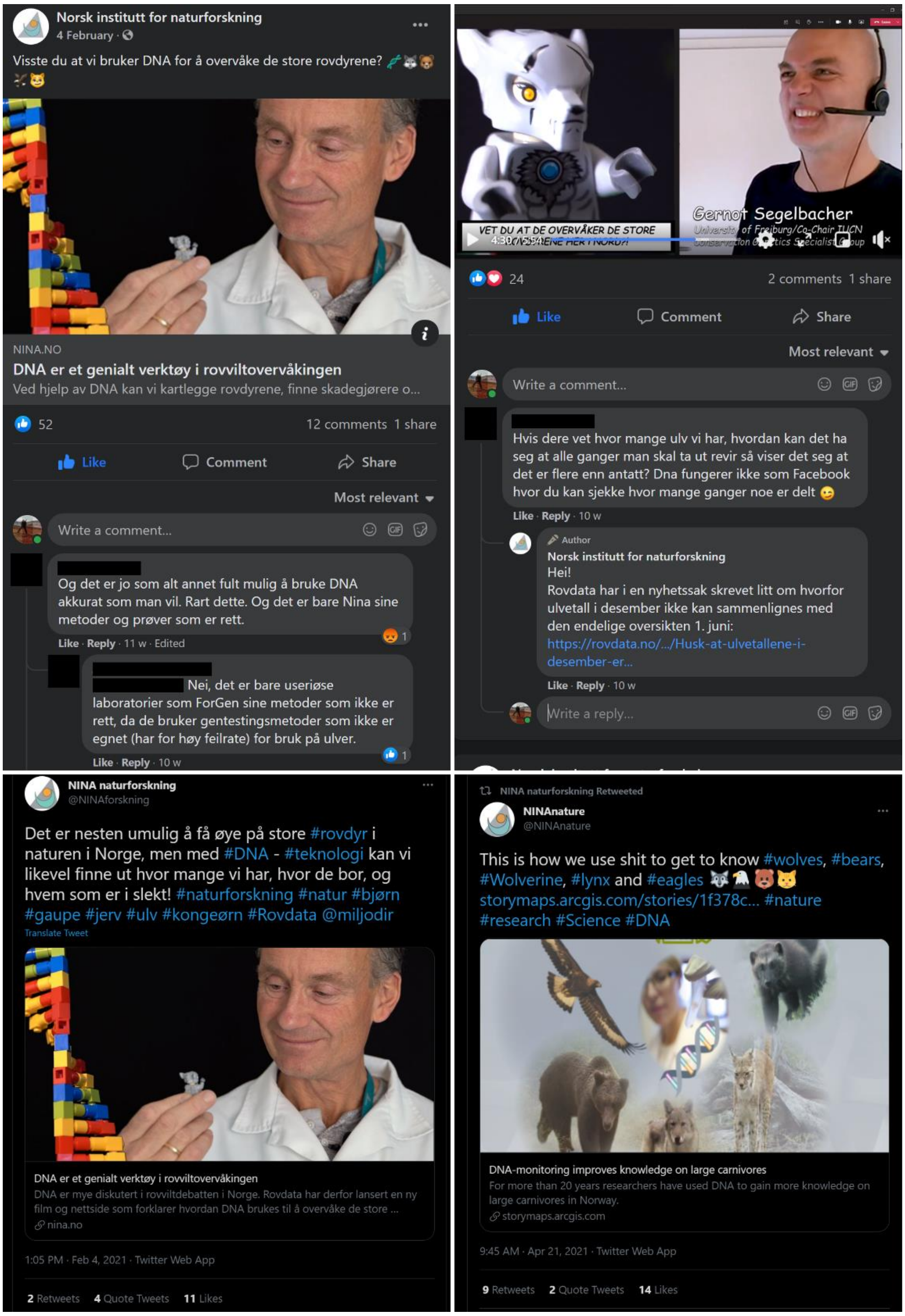


***Figure 8**. Selection of social media postings on Facebook (top) and Twitter (bottom).*

Additionally, we created first, two specific websites under ArcGIS StoryMaps, in Norwegian and in English (see Appendix 10.1 ArcGIS StoryMaps), and as well accessible under the URL www.rovdata.no/DNA. StoryMaps has become a popular media tool for scientific communication. StoryMaps allow for an interactive storytelling and especially the presentation of "scientific stories", i.e. scientific findings, to engage the public, but also stakeholders and interest groups. Here, we elaborated with more details on DNA-based monitoring of large carnivores in Norway, with more and deeper information; and more pictures. Specifically for our project, we saw the need to produce a figure, giving an overview how the process of non-invasive genetic sampling is applied and what steps, and of whom, are involved (**Figure 9**). The figure was included in the StoryMaps to make it easier to understand the whole monitoring scheme; especially to those who were unaware of its existence.

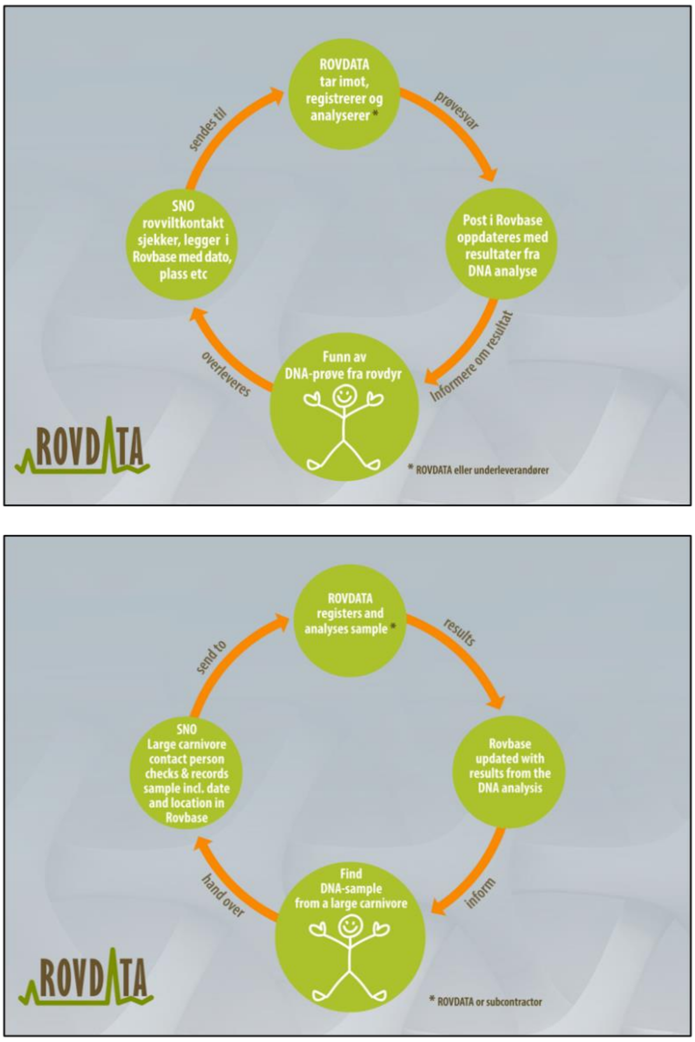


Figure 9*. Figure illustrating the process of DNA-sample collection (e.g. feces, hairs etc.) in Norway in Norwegian (top) and English (bottom).*

Secondly, a press release was composed to engage the media on the topic and to relate our movie to real events (see Appendix 10.2 Press release). The press release, including a link to the movie, was published and went out to the media, news and other relevant organizations (e.g. NRK, forskning.no, Statsforvalterne, NJFF, Naturvernforbundet, WWF Norge, Sabima, Besøkssenter rovvilt, Nationen etc.) starting February 4th, 2021, and is also available online under:

https://rovdata.no/Nyheter/Nyhetsartikkel/ArticleId/5141/DNA-er-et-genialt-verkt-248-y-i-rovviltoverv-229-kingen.aspx.

Thirdly, the Norwegian Institute for Nature Research publishes an own podcast series, "*Naturligvis - en podkast om natur, miljø og forskning*", https://www.nina.no/Aktuelt/Podcast, in which scientists talk about their research and results. NINA produced and funded a special episode on wolves and their DNA-based monitoring with senior researcher Øystein Flagstad (**Figure 10**). The episode was published April 20th 2021; to all podcast feeds and the institute's websites and social media, accompanied by the movie, for further information and education. The podcast is available under:

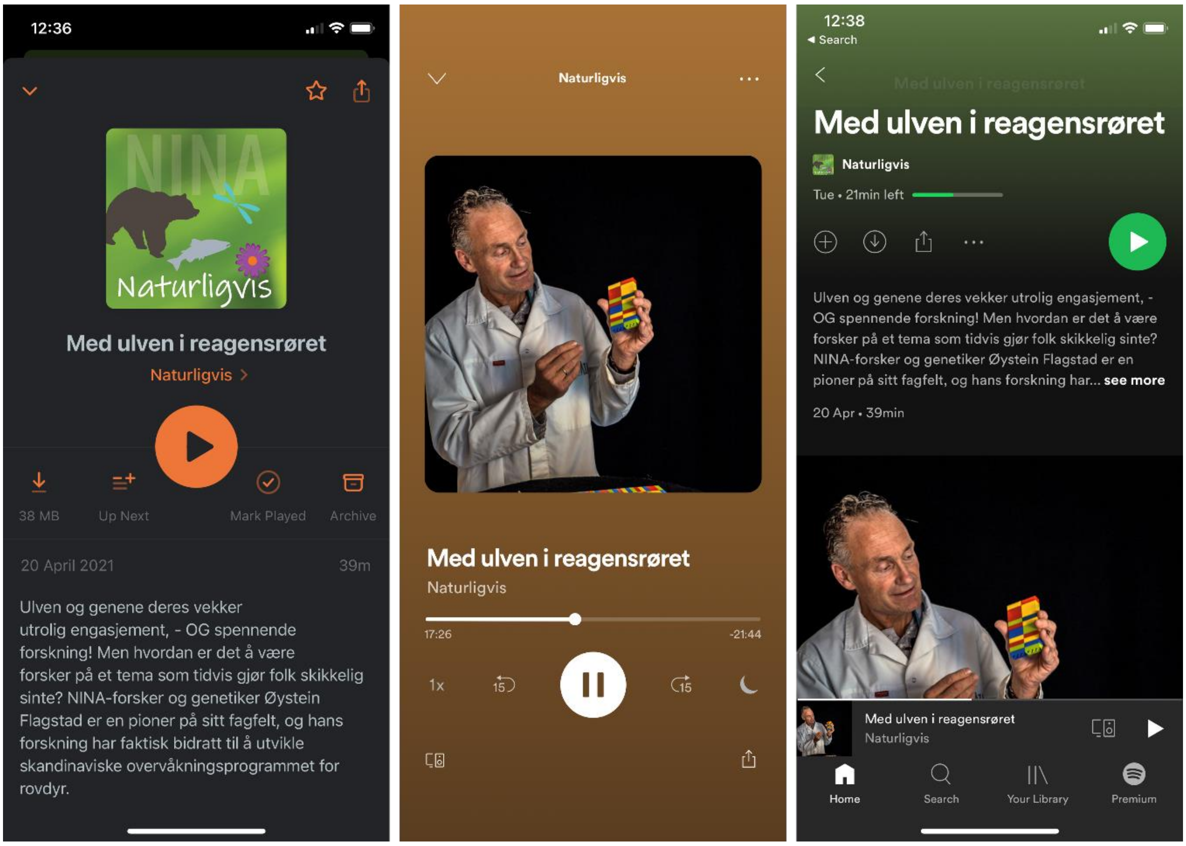


Figure 10*. Naturligvis-podcast and episode in a podcatcher and Spotify.*

6 Evaluation

By Tuesday, April 27th 2021, about ten weeks after its publication, the movie has been watched 3,680 times on YouTube and 7,539 times on Facebook (**Table 3**). The Norwegian and English StoryMaps were visited 1,288 times and 517 times, respectively. The press release published on NINA's website reached 585 visits, and published by Rovdata a total of 577 visits. The podcast has been listened to 459 times.

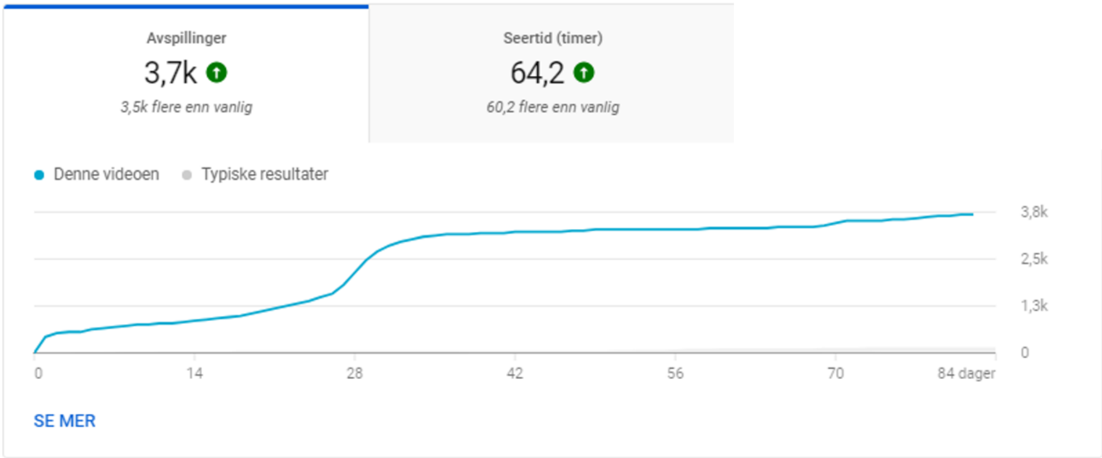
About ten weeks after the publication of the movie and additional material we reached over 14,000 impressions. These absolute numbers however, need to be looked at specifically and to be differentiated by platform and publication type. YouTube for instance, is a platform designated to publish videos. People visit YouTube specifically to consume short films, on any topic, while the social platform Facebook forms a different kind of digital ecosystem, where all kind of media can be consumed, not only video.

***Table 3**. Total number of views or visits of movie, StoryMaps, podcast and the press release.*

Channel/website	Language/page	Views/visits
YouTube		3680
Facebook		7539
StoryMaps	Norwegian	1288
	English	517
Podcast		459
Press release	NINA	585
	Rovdata	577
Total (27.04.2021)		14645

On YouTube, our movie has so far been watched a total of 3,680 times by 3,131 unique viewers. This means, a part of the audience watched the movie more than one time and indicates that viewers returned. The trajectory of the number of views showed a gradual increase in viewers, as to be expected (**Figure 11A**). A sudden increase in views was caused by implementing the video as suggestion to NINA's other videos on the platform, about 28 days after its premiere. The majority of viewers (58%) watched the movie without subtitles while about 36% enabled English, about 5% Norwegian and 1% German subtitles (**Figure 11B**). Average viewing time was comparably high with and overall average of 1:02 minutes. Most views came from the USA (22%) and Norway (13.4%). The distribution of views per country can partly be explained by YouTube's policy to suggest our movie in other, related movies or other NINA-videos (also indicated by the average viewing time: Norway: 3:12; USA: 0:13 minutes). For instance, NINA's video on Chronic Wasting Disease (CWD) has been very popular. Some traffic was caused by viewers after watching the latter. That also explained the comparably higher views in the US but also in Asia (**Figure 11C**). Analytics on YouTube further showed that over 60% of the viewers used their mobile device, while about 30% watched on their computers. Roughly 8% used a tablet (**Figure 12**).

A



B

Teksting	Avspillinger ↓		Seertidsbruk (gjennomsnitt)	Andel sett (gjennomsnitt)
Totalt	**3 680**		**1:02**	**17,7 %**
Ingen teksting	2 124	57,7 %	1:03	17,8 %
engelsk (Storbritannia)	1 319	35,8 %	0:48	13,8 %
norsk	194	5,3 %	2:16	38,5 %
tysk	43	1,2 %	2:18	39,0 %

C

Geografi	Avspillinger ↓		Seertid (timer)		Seertidsbruk (gjennomsnitt)
Totalt	**3 680**		**64,2**		**1:02**
USA	812	22,1 %	3,0	4,7 %	0:13
Norge	494	13,4 %	26,5	41,2 %	3:12
Filippinene	99	2,7 %	0,5	0,7 %	0:16
Indonesia	49	1,3 %	0,1	0,2 %	0:06
Thailand	46	1,3 %	0,1	0,1 %	0:06
Tyskland	36	1,0 %	1,0	1,5 %	1:36
Nederland	33	0,9 %	1,4	2,2 %	2:36
Sverige	29	0,8 %	1,3	2,0 %	2:37
Danmark	12	0,3 %	1,1	1,7 %	5:28
Italia	12	0,3 %	0,0	0,0 %	0:07
Brasil	11	0,3 %	0,0	0,0 %	0:06
India	10	0,3 %	0,1	0,1 %	0:21
Mexico	10	0,3 %	0,0	0,0 %	0:10

***Figure 11**. Number of impressions of the movie on YouTube (27.04.2021) and its trajectory since publication (A). The movie was published with the option to enable subtitles in Norwegian, English and German (B). Here, also the average viewing time is displayed. The last table shows a geographical spread of the movie (C); including hours of viewing and the average viewing time per viewer.*

Enhetstype	Avspillinger ↓		Seertid (timer)		Seertidsbruk (gjennomsnitt)
Totalt	**3 680**		**64,2**		**1:02**
Mobiltelefon	2 265	61,6 %	22,0	34,3 %	0:35
Datamaskin	1 116	30,3 %	39,8	62,0 %	2:08
Nettbrett	279	7,6 %	1,9	3,0 %	0:25
TV	14	0,4 %	0,4	0,7 %	1:47
Spillkonsoll	6	0,2 %	0,0	0,0 %	0:09

***Figure 12**. Terminal devices the movie has been viewed on YouTube.*

On Facebook, where the movie was posted separately, it generated a total of 7539 views; summing up three different postings by NINA, Rovdata and Miljødirektoratet (**Figure 13**). Consumption on the social media platform Facebook is much faster paced, hence the average viewing duration was only 0:09 minutes substantially lower than on YouTube. Most view counts were generated by people scrolling through their timelines.

Analytics for the StoryMaps provided just the total number of page visits (**Table 3**). The press release published on NINA's and Rovdata's websites were visited by 509 and 453 unique visitors, respectively. Again, suggesting that some visitors returned. The average length of stay was 3:40 on NINA's and 2:44 minutes on Rovdata's website, indicating further that visitors spent a reasonable time on the pages to read the information published.

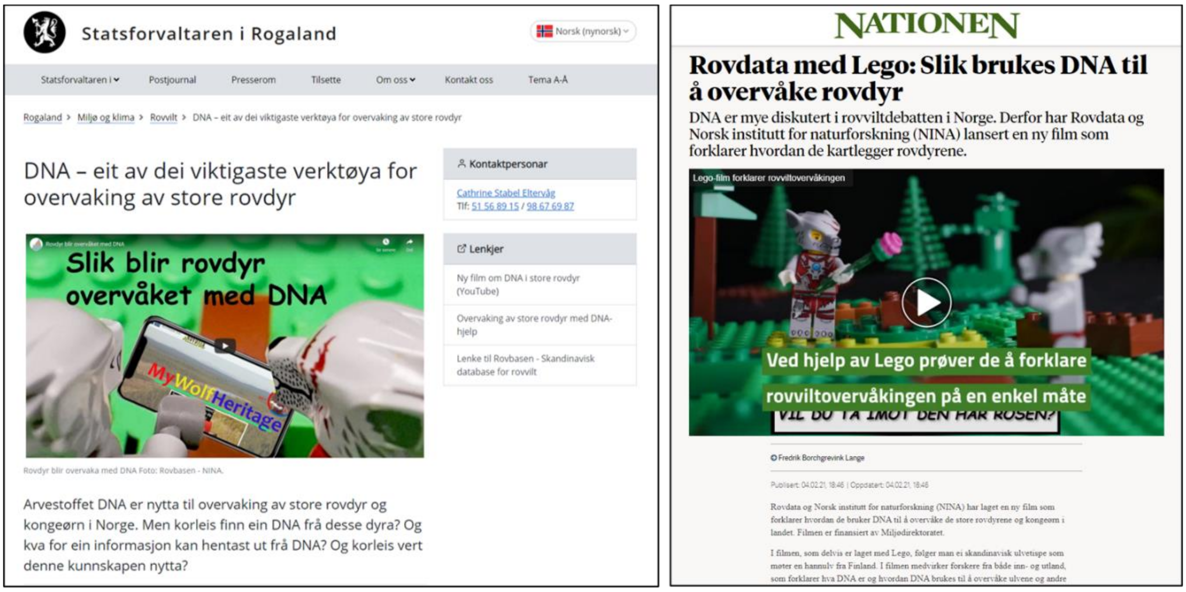
Posts Using This Video
These posts are using this video on Facebook.

Primary Posts	Distribution	People Re...	3-Second ...	15-Secon...	1-Minute ...	Average ...
Norsk institutt for naturforskning 2 months ago	-2.0x Lower	1,985	1,014	229	69	0:08
Secondary Posts (Crossposts)						
Miljødirektoratet 2 months ago	--	3,815	1,068	241	75	0:07
Rovdata 2 months ago	--	1,739	771	182	58	0:11

***Figure 13**. Impressions from the first postings of the movie on Facebook. The movie was shared by NINA, Rovdata and Miljødirektoratet. Columns further show the number of people reached, 3-Second, 15-Second and 1-Minute views, as well as the average viewing duration.*

7 Conclusion

Our aim was to present scientific facts, which may not be that exciting on a first sight to the audience, but it created some attention (**Figure 14**). It should be noted that Twitter may house some potential for further distribution and attention, e.g. as a thread presenting important points across several, connected Tweets (**Figure 15**). A similar potential lies in the use of Instagram (**Figure 16**). We disseminated an overall large amount of detailed information to be presented to the general public, where such information is clearly needed; and still answered the majority of the initial 28 questions raised (**Box I**). We deliberately did not aim to sensationalize or provoke the audience, or parts of it. If the approach we decided to use and e.g. incorporate LEGO was a good choice, we cannot conclude for certain. Alternatively, we could have split the movie in several parts to elaborate in more detail on certain aspects of non-invasive genetic monitoring of large carnivores, or produce a bunch of small, different movies for different audiences and target groups. However, we wished to present the whole story in one movie to highlight the need for a holistic approach in the large carnivore debate.


Statsforvaltaren i Rogaland

Norsk (nynorsk)

Statsforvaltaren i | Postjournal | Presserom | Tilsette | Om oss | Kontakt oss | Tema A-Å

Rogaland > Miljø og klima > Rovvilt > DNA – eit av dei viktigaste verktøya for overvaking av store rovdyr

DNA – eit av dei viktigaste verktøya for overvaking av store rovdyr

Slik blir rovdyr overvåket med DNA

MyWolfHeritage

Rovdyr blir overvaka med DNA Foto: Rovbasen - NINA.

Arvestoffet DNA er nytta til overvaking av store rovdyr og kongeørn i Norge. Men korleis finn ein DNA frå desse dyra? Og kva for ein informasjon kan hentast ut frå DNA? Og korleis vert denne kunnskapen nytta?

Kontaktpersonar

Cathrine Stabel Eltervåg

Tlf: 51 56 89 15 / 98 67 69 87

Lenkjer

Ny film om DNA i store rovdyr (YouTube)

Overvaking av store rovdyr med DNA-hjelp

Lenke til Rovbasen - Skandinavisk database for rovvilt

NATIONEN

Rovdata med Lego: Slik brukes DNA til å overvåke rovdyr

DNA er mye diskutert i rovviltdebatten i Norge. Derfor har Rovdata og Norsk institutt for naturforskning (NINA) lansert en ny film som forklarer hvordan de kartlegger rovdyrene.

Lego-film forklarer rovviltovervåkingen

Ved hjelp av Lego prøver de å forklare rovviltovervåkingen på en enkel måte

VIL DU TA IMOT DEN HAR ROSEN?

Fredrik Borchgrevink Lange

Publisert: 04.02.21, 18:46 | Oppdatert: 04.02.21, 18:46

Rovdata og Norsk institutt for naturforskning (NINA) har laget en ny film som forklarer hvordan de bruker DNA til å overvåke de store rovdyrene og kongeørn i landet. Filmen er finansiert av Miljødirektoratet.

I filmen, som delvis er laget med Lego, følger man ei skandinavisk ulvetispe som møter en hannulv fra Finland. I filmen medvirker forskere fra både inn- og utland, som forklarer hva DNA er og hvordan DNA brukes til å overvåke ulvene og andre

***Figure 14**. Examples of resonating publications on the movie.*

https://www.statsforvalteren.no/Rogaland/Miljo-og-klima/Rovvilt/dna--eit-av-dei-viktigaste-verktoya-for-overvaking-av-store-rovdyr/

https://www.nationen.no/nyhet/rovdata-med-lego-slik-brukes-dna-til-a-overvake-rovdyr/

It is also worth noting that the average reading time on the news stories was around 3 minutes. This means that people spent time on the website to read the information. Even though a majority of viewers may have got only a short glimpse of the movie while scrolling through their timelines, they were at least exposed to our information and perceived that in Norway large carnivores are monitored with DNA. Another trend which was indicating that a part of the audience seemed to return to the movie and StoryMaps is promising, and it was a goal we wanted to achieve.

Publishing information, scientific and educative content on large carnivores via a movie on YouTube and other platforms is a relatively new way to communicate for the management. We have spread the movie and additional information across the usual channels used to publicize other results and findings on large carnivores. The presented statistics on the views are collected over the course of the first 10 weeks and can be considered preliminary, as such a period is comparably short for comprehensive assessments and an educational movie aimed for a longer lifetime. The next months will further show how valuable the movie is. A movie will unlikely substitute our traditional ways, how we communicate our findings and actions, but it appears to be a valuable, and promising additional tool, especially to engage on the long term in a large, international audience. We hope the movie will further be shared and viewed as well as simply used by everyone for their needs.

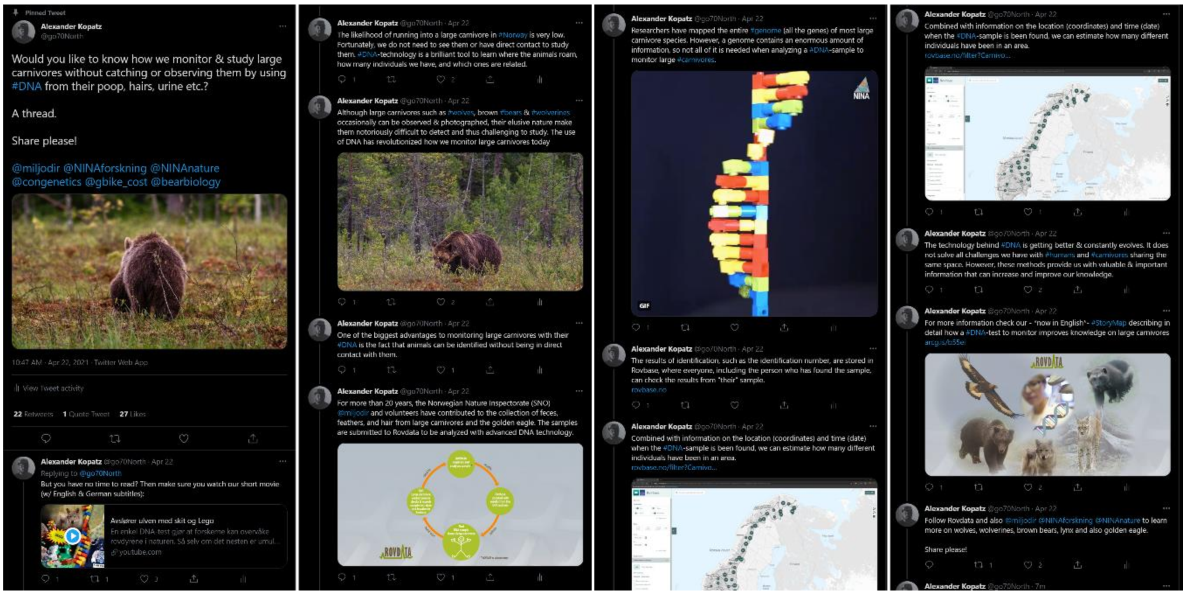


Figure 15. *A thread on the movie and StoryMaps on Twitter.*

Figure 16. *Repost by an user of an Instagram-story on the movie by NINA.*

8 Acknowledgements

We would like to thank everyone involved, Tore Solstad from the Norwegian State Nature Inspectorate, Siv Grethe Aarnes and Elisa Keeling Hemphill from the Norwegian Environment Agency, Gernot Segelbacher from the University of Freiburg, Germany and Co-chair of the IUCN SSC Conservation Genetics Specialist Group, Sten Karlsson, Jørn Fremstad, Anne Olga Syverhuset and Kari Sivertsen from the Norwegian Institute for Nature Research. For inspiring and constructive discussions we would like to thank further Veronica Sahlén and Jan Paul Bolstad (Norwegian State Nature Inspectorate), Michael W. Bruford (Cardiff University), Carsten Nowak (Senckenberg Research Institute), Tomaz Skrbinšek (University of Ljubljana), Joachim Mergeay (INBO Research Institute for Nature and Forest & University of Leuven), as well as our colleagues Jonas Kindberg, Oddmund Kleven, Henrik Brøseth, John Odden, Jenny Mattison, Frode Holmstrøm, Mari Tovmo, Camilla Næss and Bjørg Bruset for the support, valuable feedback and constructive critic while producing this movie. We further would like to thank SCANDCAM (https://viltkamera.nina.no/) to provide us with recorded footage from the field.

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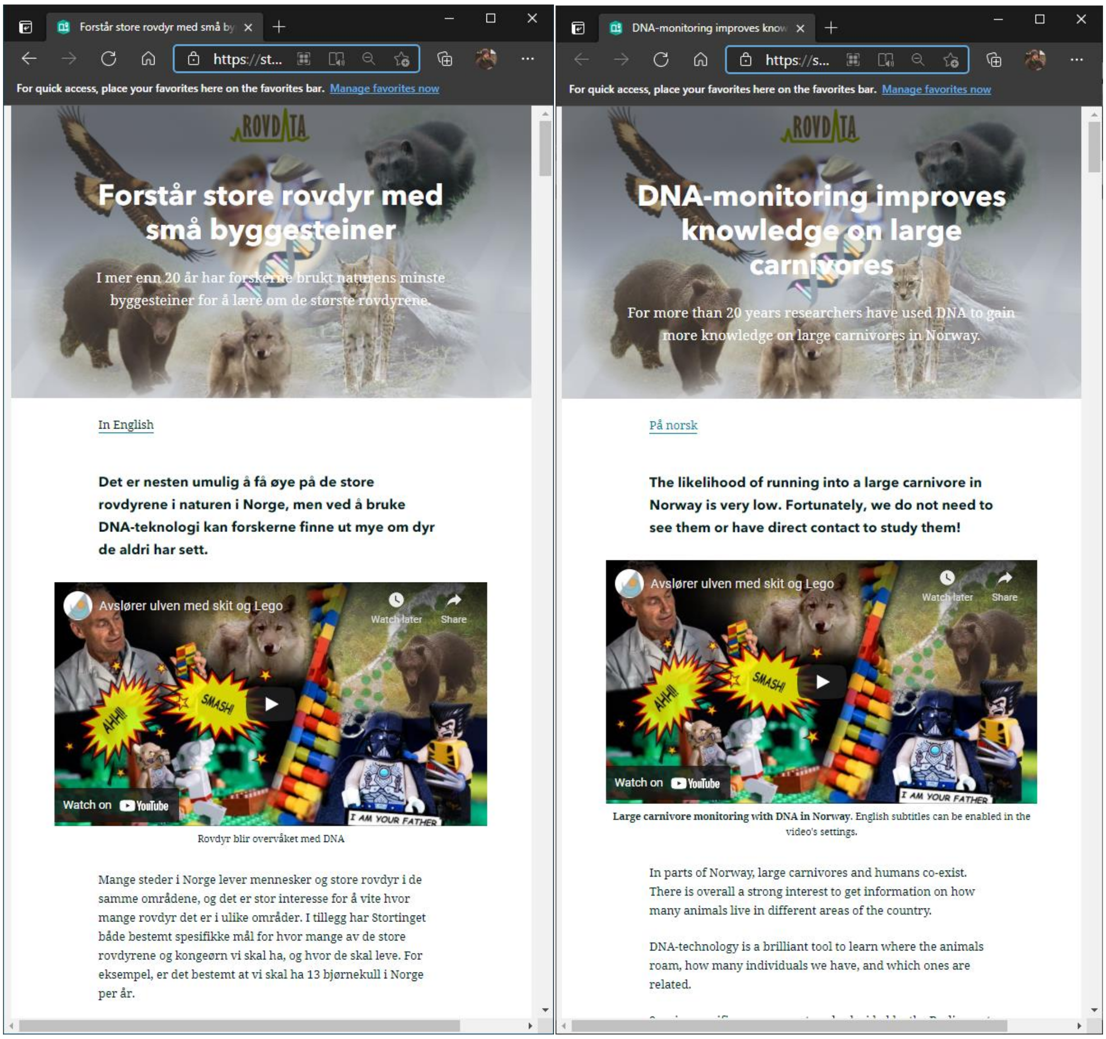
10 Appendices

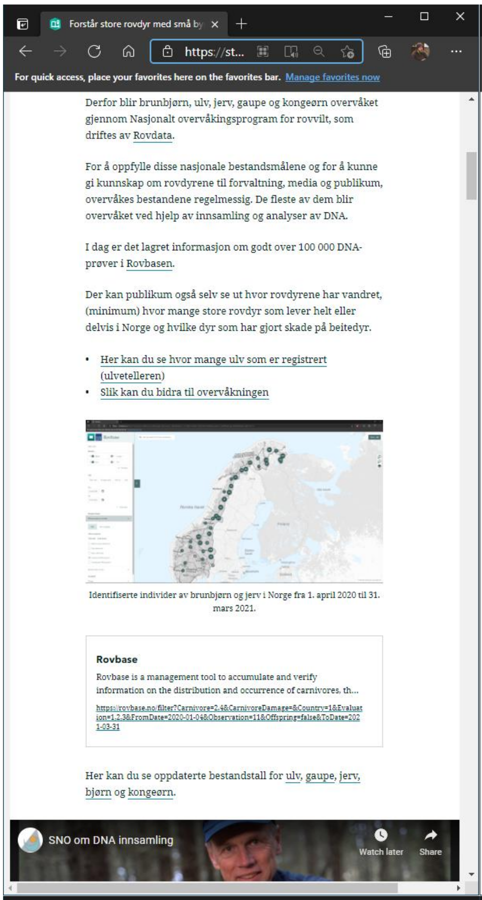
10.1 ArcGIS StoryMaps

ArcGIS StoryMaps on DNA-based monitoring of large carnivores and golden eagle in Norway: in Norwegian (left) and English (right).

Published and accessible under www.rovdata.no/DNA, with specific URLs

- Norwegian: https://storymaps.arcgis.com/stories/0e97d657cfb4467487473b8ea94f9e80
- English: https://storymaps.arcgis.com/stories/1f378c6b268c45419a5d38d29fc9a799




Forstår store rovdyr med små by

For quick access, place your favorites here on the favorites bar. Manage favorites now

Derfor blir brunbjørn, ulv, jerv, gaupe og kongeørn overvåket gjennom Nasjonalt overvåkingsprogram for rovvilt, som driftes av Rovdata.

For å oppfylle disse nasjonale bestandsmålene og for å kunne gi kunnskap om rovdyrene til forvaltning, media og publikum, overvåkes bestandene regelmessig. De fleste av dem blir overvåket ved hjelp av innsamling og analyser av DNA.

I dag er det lagret informasjon om godt over 100 000 DNA-prøver i Rovbasen.

Der kan publikum også selv se ut hvor rovdyrene har vandret, (minimum) hvor mange store rovdyr som lever helt eller delvis i Norge og hvilke dyr som har gjort skade på beitedyr.

- Her kan du se hvor mange ulv som er registrert (ulvetelleren)
- Slik kan du bidra til overvåkningen

Identifiserte individer av brunbjørn og jerv i Norge fra 1. april 2020 til 31. mars 2021.

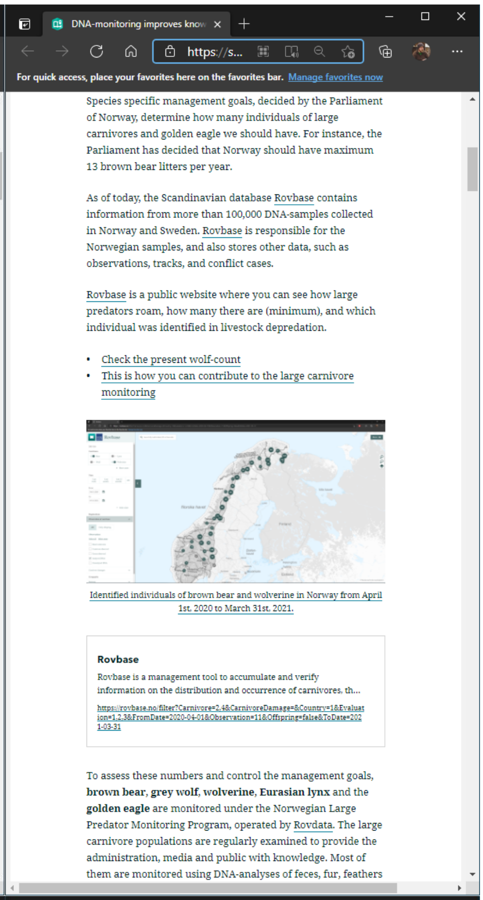
Rovbase

Rovbase is a management tool to accumulate and verify information on the distribution and occurrence of carnivores, th...

https://rovbase.no/filter?Carnivore=2,4&CarnivoreDamage=&Country=1&Evaluation=1,2,3&FromDate=2020-01-04&Observation=11&Offspring=false&ToDate=2021-03-31

Her kan du se oppdaterte bestandstall for ulv, gaupe, jerv, bjørn og kongeørn.

SNO om DNA innsamling
Watch later
Share


DNA-monitoring improves know

For quick access, place your favorites here on the favorites bar. Manage favorites now

Species specific management goals, decided by the Parliament of Norway, determine how many individuals of large carnivores and golden eagle we should have. For instance, the Parliament has decided that Norway should have maximum 13 brown bear litters per year.

As of today, the Scandinavian database Rovbase contains information from more than 100,000 DNA-samples collected in Norway and Sweden. Rovbase is responsible for the Norwegian samples, and also stores other data, such as observations, tracks, and conflict cases.

Rovbase is a public website where you can see how large predators roam, how many there are (minimum), and which individual was identified in livestock depredation.

- Check the present wolf-count
- This is how you can contribute to the large carnivore monitoring

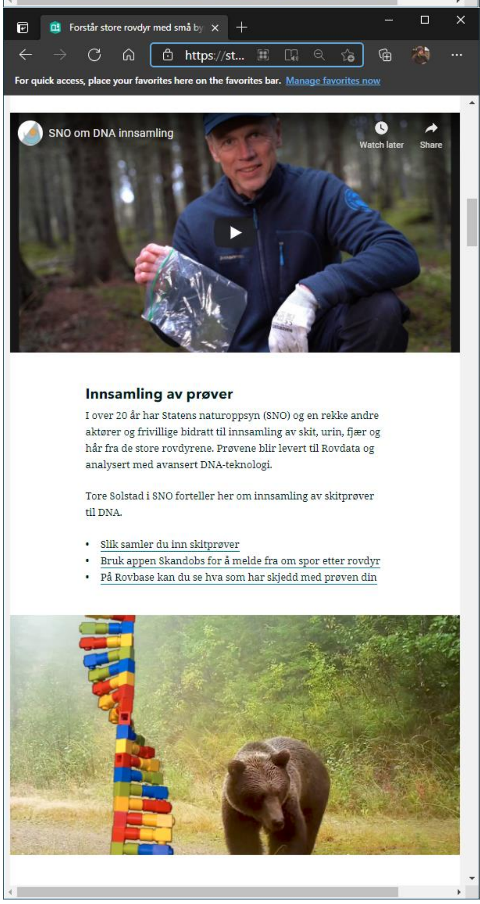
Identified individuals of brown bear and wolverine in Norway from April 1st, 2020 to March 31st, 2021.

Rovbase

Rovbase is a management tool to accumulate and verify information on the distribution and occurrence of carnivores, th...

https://rovbase.no/filter?Carnivore=2,4&CarnivoreDamage=&Country=1&Evaluation=1,2,3&FromDate=2020-04-01&Observation=11&Offspring=false&ToDate=2021-03-31

To assess these numbers and control the management goals, **brown bear**, **grey wolf**, **wolverine**, **Eurasian lynx** and the **golden eagle** are monitored under the Norwegian Large Predator Monitoring Program, operated by Rovdata. The large carnivore populations are regularly examined to provide the administration, media and public with knowledge. Most of them are monitored using DNA-analyses of feces, fur, feathers


Forstår store rovdyr med små by

For quick access, place your favorites here on the favorites bar. Manage favorites now

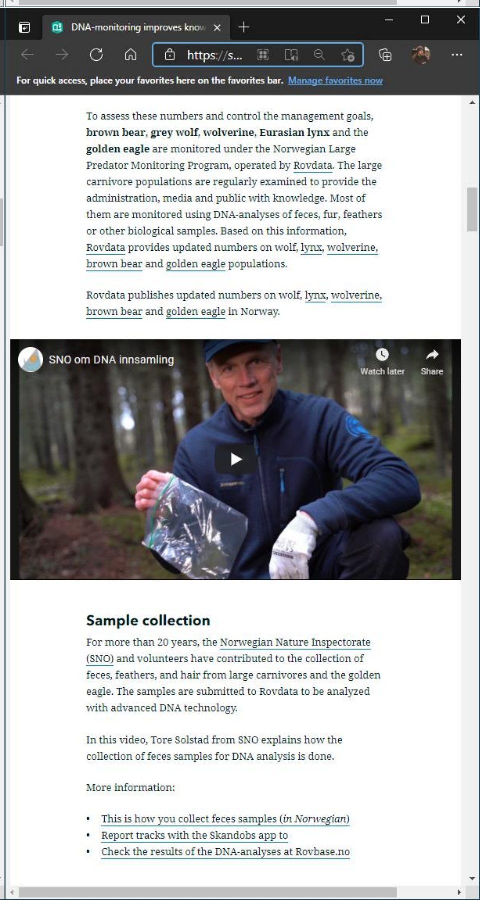
SNO om DNA innsamling
Watch later
Share

Innsamling av prøver

I over 20 år har Statens naturoppsyn (SNO) og en rekke andre aktører og frivillige bidratt til innsamling av skit, urin, fjær og hår fra de store rovdyrene. Prøvene blir levert til Rovdata og analysert med avansert DNA-teknologi.

Tore Solstad i SNO forteller her om innsamling av skitprøver til DNA.

- Slik samler du inn skitprøver
- Bruk appen Skandobs for å melde fra om spor etter rovdyr
- På Rovbase kan du se hva som har skjedd med prøven din


DNA-monitoring improves know

For quick access, place your favorites here on the favorites bar. Manage favorites now

To assess these numbers and control the management goals, **brown bear**, **grey wolf**, **wolverine**, **Eurasian lynx** and the **golden eagle** are monitored under the Norwegian Large Predator Monitoring Program, operated by Rovdata. The large carnivore populations are regularly examined to provide the administration, media and public with knowledge. Most of them are monitored using DNA-analyses of feces, fur, feathers or other biological samples. Based on this information, Rovdata provides updated numbers on wolf, lynx, wolverine, brown bear and golden eagle populations.

Rovdata publishes updated numbers on wolf, lynx, wolverine, brown bear and golden eagle in Norway.

SNO om DNA innsamling
Watch later
Share

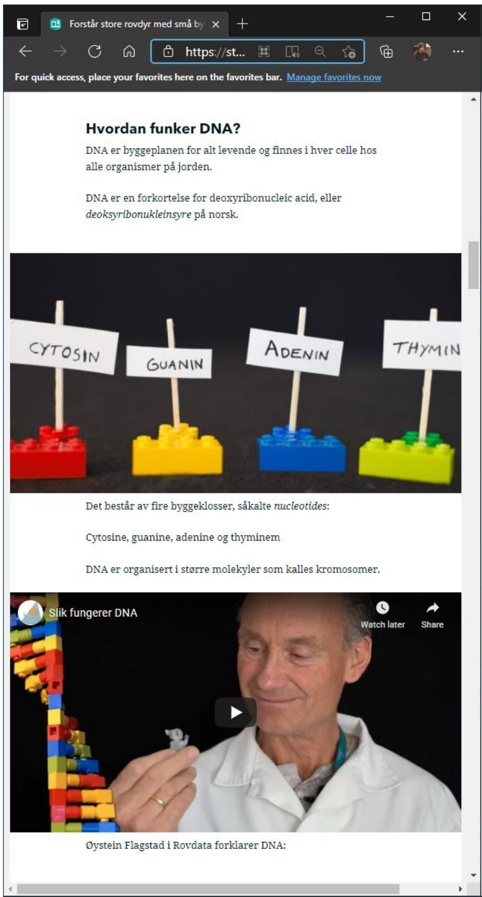
Sample collection

For more than 20 years, the Norwegian Nature Inspectorate (SNO) and volunteers have contributed to the collection of feces, feathers, and hair from large carnivores and the golden eagle. The samples are submitted to Rovdata to be analyzed with advanced DNA technology.

In this video, Tore Solstad from SNO explains how the collection of feces samples for DNA analysis is done.

More information:

- This is how you collect feces samples (*in Norwegian*)
- Report tracks with the Skandobs app to
- Check the results of the DNA-analyses at Rovbase.no



Hvordan funker DNA?

DNA er byggeplanen for alt levende og finnes i hver celle hos alle organismer på jorden.

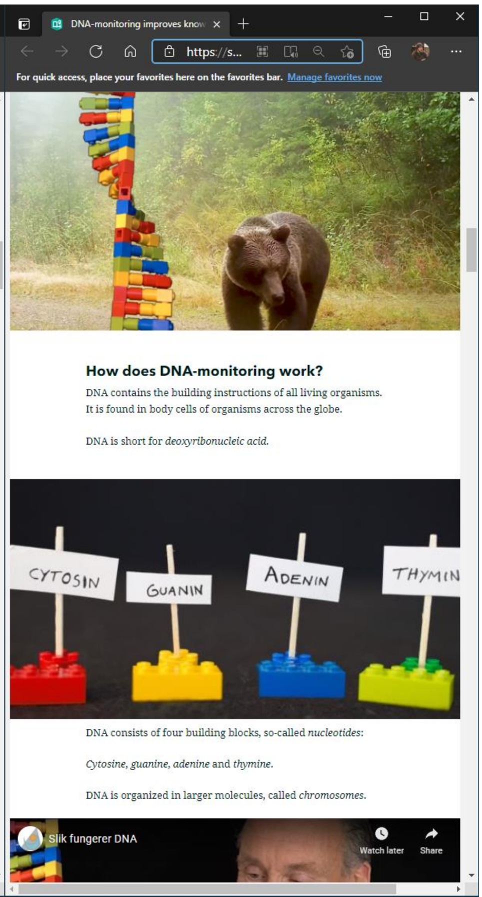
DNA er en forkortelse for deoxyribonucleic acid, eller *deoksyribonukleinsyre* på norsk.

Det består av fire byggeklosser, såkalte *nucleotides*:

Cytosine, guanine, adenine og thyminem

DNA er organisert i større molekyler som kalles kromosomer.

Øystein Flagstad i Rovdata forklarer DNA:



How does DNA-monitoring work?

DNA contains the building instructions of all living organisms. It is found in body cells of organisms across the globe.

DNA is short for *deoxyribonucleic acid.*

DNA consists of four building blocks, so-called *nucleotides*:

Cytosine, guanine, adenine and *thymine.*

DNA is organized in larger molecules, called *chromosomes.*

DNA har revolusjonert måten vi overvåker rovdyr

Forskerne har faktisk kartlagt alle genene (genomet) til de fleste rovdyrene, men de trenger ikke se på den enorme informasjonsmengden i hele genomet hver gang de sjekker en DNA-prøve.

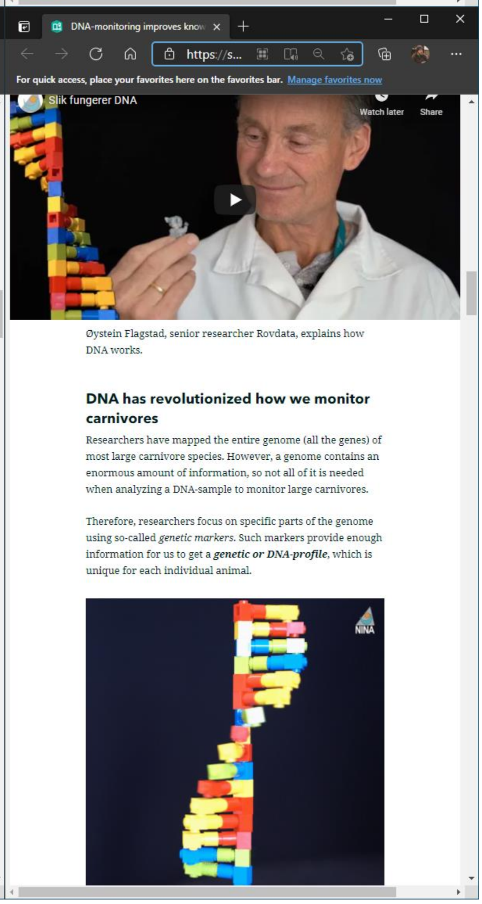
Forskerne bruker heller en metode med genetiske markører der de bare analyserer en liten del av DNA'et. Med slike markører får de en DNA-profil, et fingeravtrykk, som er helt unik for hvert individ.

Forenklet modell av en DNA dobbel heliks: strukturen av DNA-molekylet.

For å få DNA-profilen til for eksempel en bjørn eller en ulv, trenger vi en biologisk prøve fra dem. Det kan være skit, hår, fjær, urin, spytt, vev eller blod. De fleste DNA-prøvene som analyseres i overvåkningen kommer fra skit, hår og urin, og kan faktisk samles inn flere uker etter at dyrene har etterlatt det i naturen.

En av de store fordelene med å bruke DNA til å overvåke dyr er nettopp det at vi kan identifisere dyrene uten å være i kontakt med dem.

Når man i tillegg har informasjon om sted (koordinater) og dato kan vi beregne hvor mange forskjellige dyr som har vært i et område.

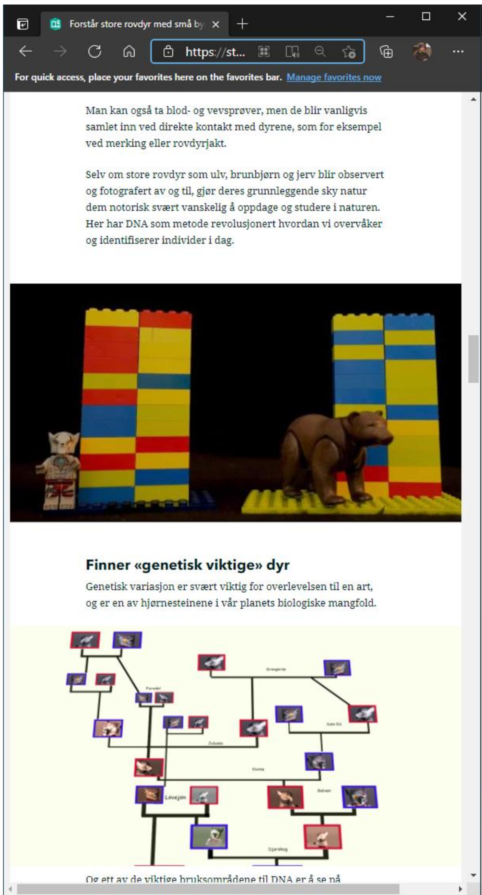


Øystein Flagstad, senior researcher Rovdata, explains how DNA works.

DNA has revolutionized how we monitor carnivores

Researchers have mapped the entire genome (all the genes) of most large carnivore species. However, a genome contains an enormous amount of information, so not all of it is needed when analyzing a DNA-sample to monitor large carnivores.

Therefore, researchers focus on specific parts of the genome using so-called *genetic markers*. Such markers provide enough information for us to get a ***genetic or DNA-profile***, which is unique for each individual animal.



Forstår store rovdyr med små by

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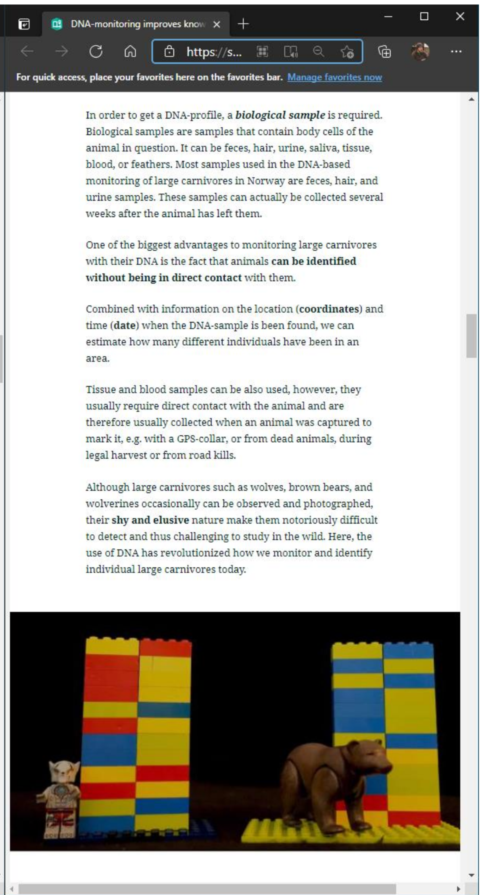
Man kan også ta blod- og vevsprøver, men de blir vanligvis samlet inn ved direkte kontakt med dyrene, som for eksempel ved merking eller rovdyrjakt.

Selv om store rovdyr som ulv, brunbjørn og jerv blir observert og fotografert av og til, gjør deres grunnleggende sky natur dem notorisk svært vanskelig å oppdage og studere i naturen. Her har DNA som metode revolusjonert hvordan vi overvåker og identifiserer individer i dag.

Finner «genetisk viktige» dyr

Genetisk variasjon er svært viktig for overlevelsen til en art, og er en av hjørnesteinene i vår planets biologiske mangfold.

Og ett av de viktige bruksområdene til DNA er å se på



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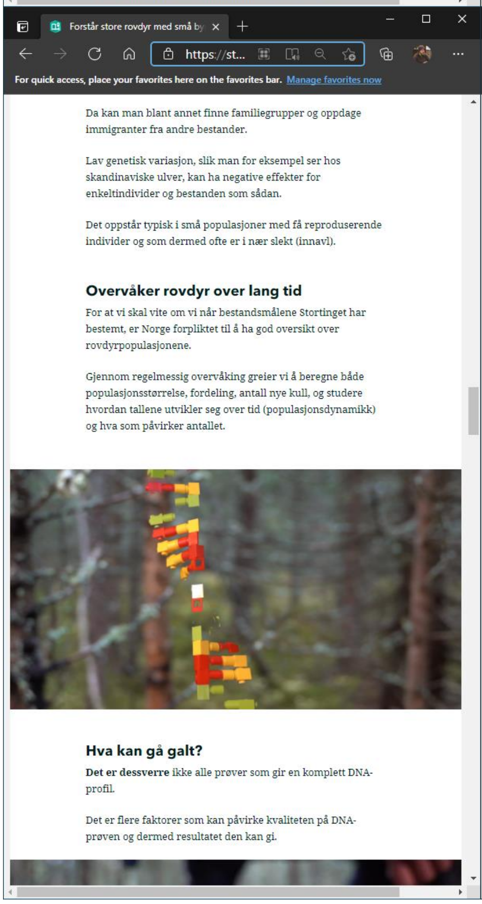
In order to get a DNA-profile, a ***biological sample*** is required. Biological samples are samples that contain body cells of the animal in question. It can be feces, hair, urine, saliva, tissue, blood, or feathers. Most samples used in the DNA-based monitoring of large carnivores in Norway are feces, hair, and urine samples. These samples can actually be collected several weeks after the animal has left them.

One of the biggest advantages to monitoring large carnivores with their DNA is the fact that animals **can be identified without being in direct contact** with them.

Combined with information on the location (**coordinates**) and time (**date**) when the DNA-sample is been found, we can estimate how many different individuals have been in an area.

Tissue and blood samples can be also used, however, they usually require direct contact with the animal and are therefore usually collected when an animal was captured to mark it, e.g. with a GPS-collar, or from dead animals, during legal harvest or from road kills.

Although large carnivores such as wolves, brown bears, and wolverines occasionally can be observed and photographed, their **shy and elusive** nature make them notoriously difficult to detect and thus challenging to study in the wild. Here, the use of DNA has revolutionized how we monitor and identify individual large carnivores today.



Forstår store rovdyr med små by

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Da kan man blant annet finne familiegrupper og oppdage immigranter fra andre bestander.

Lav genetisk variasjon, slik man for eksempel ser hos skandinaviske ulver, kan ha negative effekter for enkeltindivider og bestanden som sådan.

Det oppstår typisk i små populasjoner med få reproduserende individer og som dermed ofte er i nær slekt (innavl).

Overvåker rovdyr over lang tid

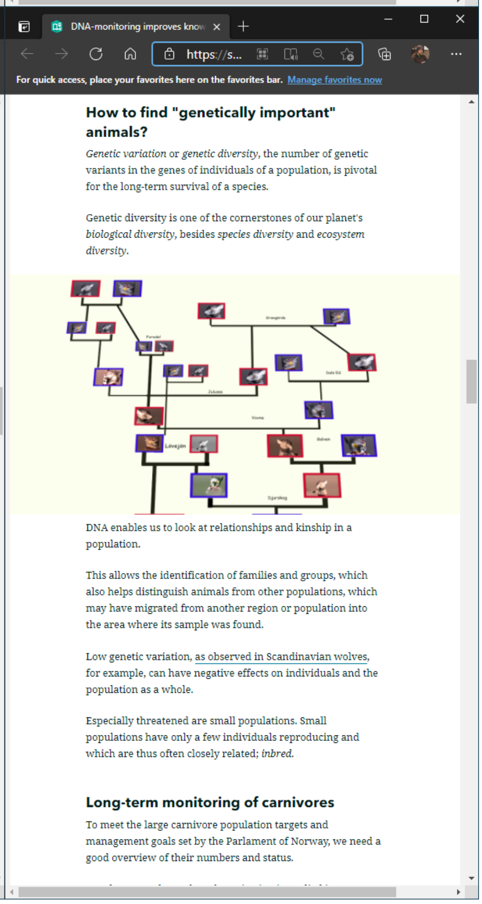
For at vi skal vite om vi når bestandsmålene Stortinget har bestemt, er Norge forpliktet til å ha god oversikt over rovdyrpopulasjonene.

Gjennom regelmessig overvåking greier vi å beregne både populasjonsstørrelse, fordeling, antall nye kull, og studere hvordan tallene utvikler seg over tid (populasjonsdynamikk) og hva som påvirker antallet.

Hva kan gå galt?

Det er dessverre ikke alle prøver som gir en komplett DNA-profil.

Det er flere faktorer som kan påvirke kvaliteten på DNA-prøven og dermed resultatet den kan gi.



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How to find "genetically important" animals?

Genetic variation or *genetic diversity*, the number of genetic variants in the genes of individuals of a population, is pivotal for the long-term survival of a species.

Genetic diversity is one of the cornerstones of our planet's *biological diversity*, besides *species diversity* and *ecosystem diversity*.

DNA enables us to look at relationships and kinship in a population.

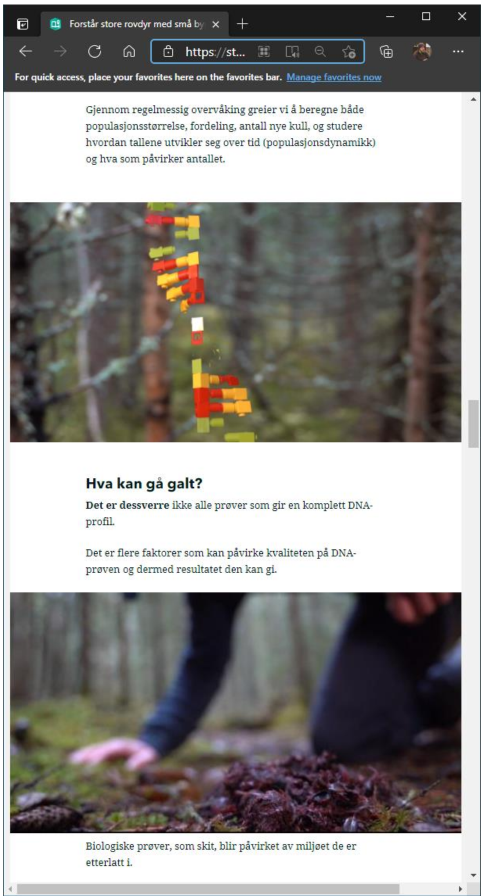
This allows the identification of families and groups, which also helps distinguish animals from other populations, which may have migrated from another region or population into the area where its sample was found.

Low genetic variation, as observed in Scandinavian wolves, for example, can have negative effects on individuals and the population as a whole.

Especially threatened are small populations. Small populations have only a few individuals reproducing and which are thus often closely related; *inbred*.

Long-term monitoring of carnivores

To meet the large carnivore population targets and management goals set by the Parlament of Norway, we need a good overview of their numbers and status.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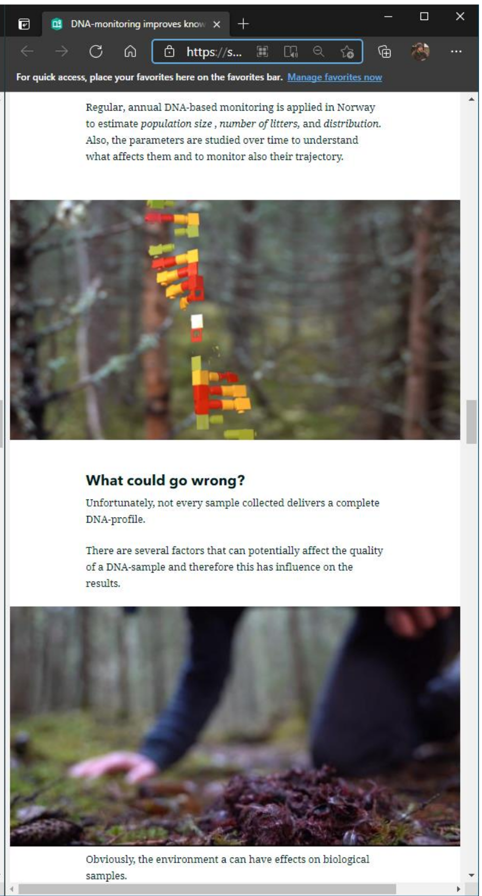
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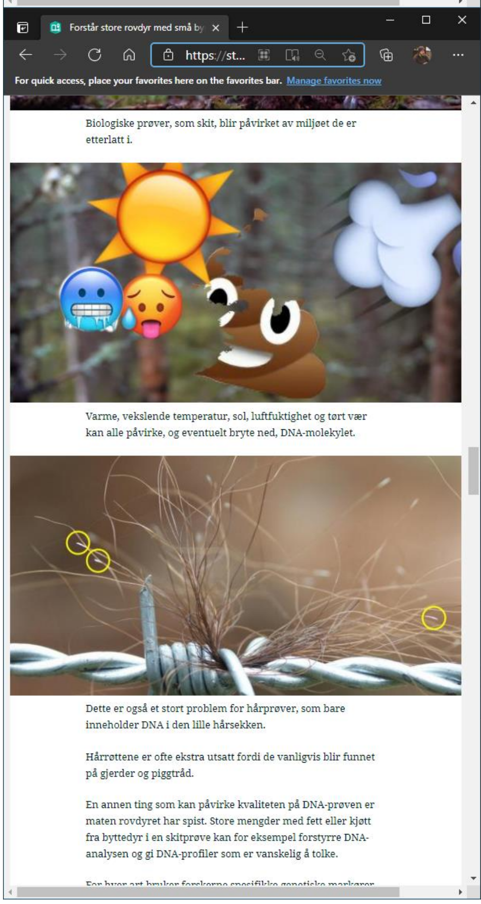
Regular, annual DNA-based monitoring is applied in Norway to estimate population size , number of litters, and distribution. Also, the parameters are studied over time to understand what affects them and to monitor also their trajectory.
What could go wrong?
Unfortunately, not every sample collected delivers a complete DNA-profile.
There are several factors that can potentially affect the quality of a DNA-sample and therefore this has influence on the results.
Obviously, the environment a can have effects on biological samples.


Forstår store rovdyr med små by
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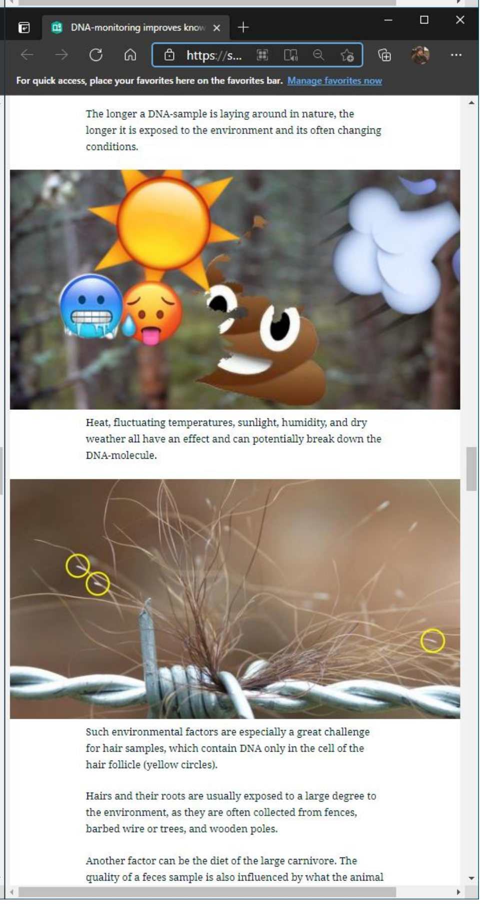
Biologiske prøver, som skit, blir påvirket av miljøet de er etterlatt i.
Varme, vekslende temperatur, sol, luftfuktighet og tørt vær kan alle påvirke, og eventuelt bryte ned, DNA-molekylet.
Dette er også et stort problem for hårprøver, som bare inneholder DNA i den lille hårsekken.
Hårrøttene er ofte ekstra utsatt fordi de vanligvis blir funnet på gjerder og piggtråd.
En annen ting som kan påvirke kvaliteten på DNA-prøven er maten rovdyret har spist. Store mengder med fett eller kjøtt fra byttedyr i en skitprøve kan for eksempel forstyrre DNA-analysen og gi DNA-profiler som er vanskelig å tolke.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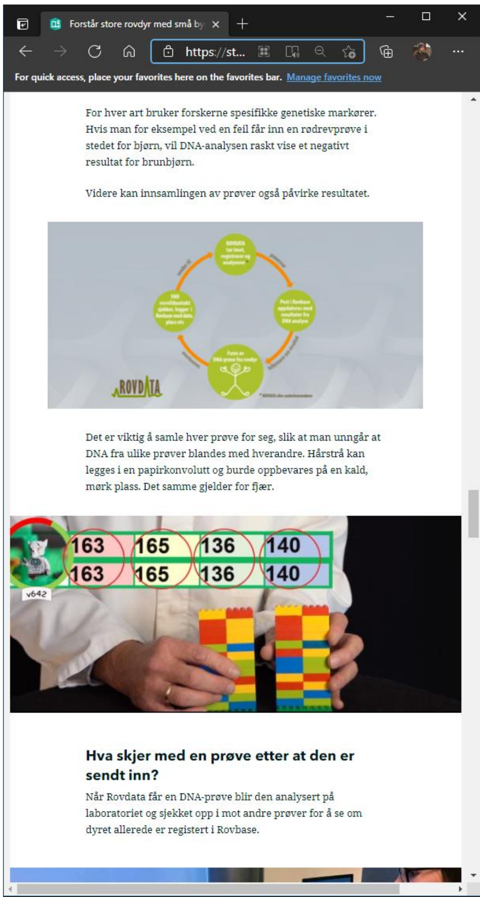
The longer a DNA-sample is laying around in nature, the longer it is exposed to the environment and its often changing conditions.
Heat, fluctuating temperatures, sunlight, humidity, and dry weather all have an effect and can potentially break down the DNA-molecule.
Such environmental factors are especially a great challenge for hair samples, which contain DNA only in the cell of the hair follicle (yellow circles).
Hairs and their roots are usually exposed to a large degree to the environment, as they are often collected from fences, barbed wire or trees, and wooden poles.
Another factor can be the diet of the large carnivore. The quality of a feces sample is also influenced by what the animal



Forstår store rovdyr med små by

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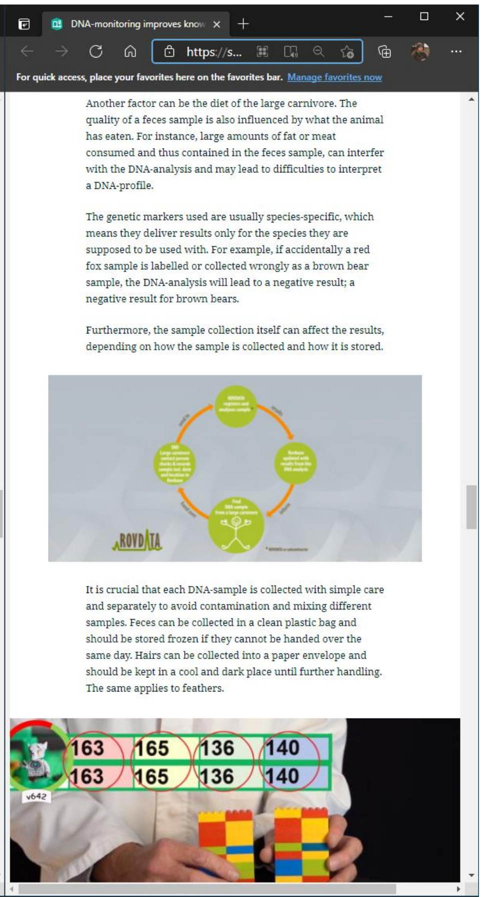
For hver art bruker forskerne spesifikke genetiske markører. Hvis man for eksempel ved en feil får inn en rødrevprøve i stedet for bjørn, vil DNA-analysen raskt vise et negativt resultat for brunbjørn.

Videre kan innsamlingen av prøver også påvirke resultatet.

Det er viktig å samle hver prøve for seg, slik at man unngår at DNA fra ulike prøver blandes med hverandre. Hårstrå kan legges i en papirkonvolutt og burde oppbevares på en kald, mørk plass. Det samme gjelder for fjær.

Hva skjer med en prøve etter at den er sendt inn?

Når Rovdata får en DNA-prøve blir den analysert på laboratoriet og sjekket opp i mot andre prøver for å se om dyret allerede er registrert i Rovbase.



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Another factor can be the diet of the large carnivore. The quality of a feces sample is also influenced by what the animal has eaten. For instance, large amounts of fat or meat consumed and thus contained in the feces sample, can interfer with the DNA-analysis and may lead to difficulties to interpret a DNA-profile.

The genetic markers used are usually species-specific, which means they deliver results only for the species they are supposed to be used with. For example, if accidentally a red fox sample is labelled or collected wrongly as a brown bear sample, the DNA-analysis will lead to a negative result; a negative result for brown bears.

Furthermore, the sample collection itself can affect the results, depending on how the sample is collected and how it is stored.

It is crucial that each DNA-sample is collected with simple care and separately to avoid contamination and mixing different samples. Feces can be collected in a clean plastic bag and should be stored frozen if they cannot be handed over the same day. Hairs can be collected into a paper envelope and should be kept in a cool and dark place until further handling. The same applies to feathers.

Forstår store rovdyr med små by

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Slik foregår det:

1: Sjekker om prøven er registrert i Rovbase.

2: Skitprøven fryses ned til -80 grader i tre dager for å drepe mulige parasitter.

3: Laboratoriet tar en del av prøven til såkalt DNA-ekstraksjon, der man isolerer DNA'et som finnes i prøven.

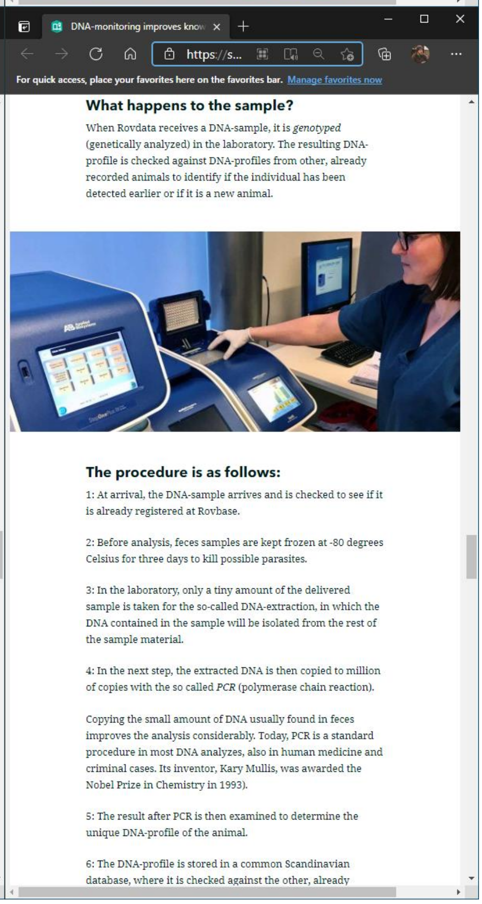
4: DNAet økes til millioner av kopier i en såkalt PCR (the polymerase-chain-reaction).

(Ved å kopiere det lille materialet man har, så forbedres analysene betraktelig.PCR er i dag en standard prosedyre i de fleste DNA-analyser, også i medisin og kriminalsaker)

5: Resultatet undersøkes og analyseres for å fastslå den unike DNA-profilen til dyret.

6: DNA-profilen lagres i en felles skandinavisk database, der den sjekkes opp mot allerede kjente DNA-profiler.

7: Den som har levert prøven kan finne igjen «sin» prøve i Rovbase.



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What happens to the sample?

When Rovdata receives a DNA-sample, it is *genotyped* (genetically analyzed) in the laboratory. The resulting DNA-profile is checked against DNA-profiles from other, already recorded animals to identify if the individual has been detected earlier or if it is a new animal.

The procedure is as follows:

1: At arrival, the DNA-sample arrives and is checked to see if it is already registered at Rovbase.

2: Before analysis, feces samples are kept frozen at -80 degrees Celsius for three days to kill possible parasites.

3: In the laboratory, only a tiny amount of the delivered sample is taken for the so-called DNA-extraction, in which the DNA contained in the sample will be isolated from the rest of the sample material.

4: In the next step, the extracted DNA is then copied to million of copies with the so called *PCR* (polymerase chain reaction).

Copying the small amount of DNA usually found in feces improves the analysis considerably. Today, PCR is a standard procedure in most DNA analyzes, also in human medicine and criminal cases. Its inventor, Kary Mullis, was awarded the Nobel Prize in Chemistry in 1993).

5: The result after PCR is then examined to determine the unique DNA-profile of the animal.

6: The DNA-profile is stored in a common Scandinavian database, where it is checked against the other, already

Forstår store rovdyr med små by

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Hvorfor er dette viktig informasjon for samfunnet vårt?

DNA-teknologien er i stadig utvikling. DNA er ikke løsningen på alle problemene vi møter i en sameksistens med store rovdyr, men metodene gir oss mer og verdifull informasjon som øker og forbedrer vår kunnskap.

Slik kunnskap bidrar til mer effektiv forvaltning og overvåking, for å sikre overlevelse av arter og bestander. Videre til bedre konflikthåndtering. Rett og slett danne et bedre grunnlag for en bærekraftig forvaltning av store rovdyr.

FAKTA OM BJØRN

Brunbjørnen *(Ursus arctos)* er det største rovdyret på det norske fastlandet.

Den er sterkt truet av utryddelse i Norge.

I 2019 ble det påvist minst 148 brunbjørner i Norge ved hjelp

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7: The results of identification, such as the identification number, are stored in Rovbase, where everyone, including the person who has found the sample, can check the results from "their" sample.

Why is this information important for us, our society?

The technology behind DNA and its analysis is getting better and constantly evolves. It does not solve all the challenges we have with humans and carnivores sharing the same space. However, these methods provide us with valuable and especially important information that can increase and improve our knowledge on large carnivores.

This knowledge allows for a more efficient monitoring and management of large carnivores and ensures the survival of the species and local populations. With that it contributes to better conflict solutions. The additional knowledge provides us with a much better basis for sustainable management of large carnivores.

Brown bear

The brown bear *(Ursus arctos)* is the largest of the carnivore species on the Norwegian mainland.

The species is endangered in Norway.

In 2019, a minimum number of 148 brown bears were detected in Norway using DNA analyzes. 57 were female

Forstår store rovdyr med små by

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I 2019 ble det påvist minst 148 brunbjørner i Norge ved hjelp av DNA-analyser. 57 av dem var hunnbjørner, mens 91 var hannbjørner. På Rovdata finner du oppdaterte bestandstall.

Voksne hannbjørner veier fra 100 til 300 kilo, mens binnene er noe mindre og veier fra 60 til 200 kilo.

Den er alteter og henter mat fra både dyreriket og planteriket. Mesteparten av energien får den fra bær, maur og byttedyr, som kalver fra elg og rein. Den spiser også sau om sjansen skulle by seg. I tillegg spiser bjørnen urter og gress.

Foto: Arne Nævra

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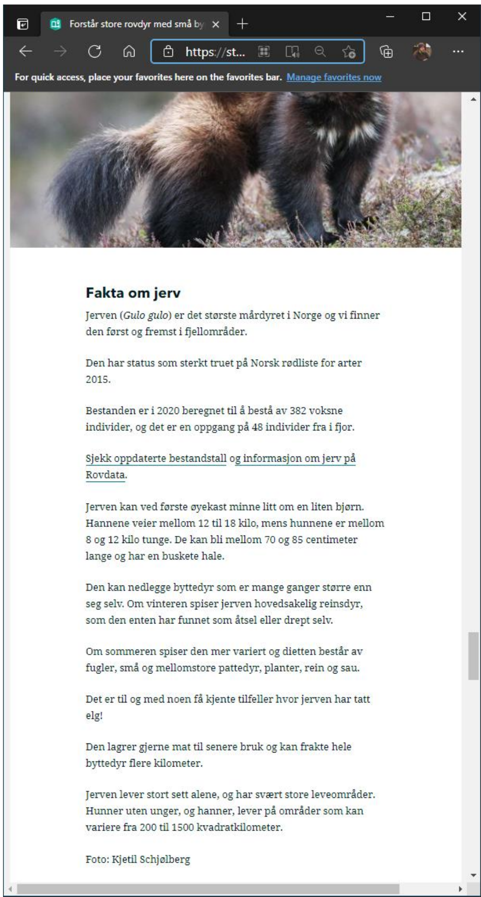
Foto: Arne Nævra



Fakta om jerv

Jerven (*Gulo gulo*) er det største mårdyret i Norge og vi finner den først og fremst i fjellområder.

Den har status som sterkt truet på Norsk rødliste for arter 2015.

Bestanden er i 2020 beregnet til å bestå av 382 voksne individer, og det er en oppgang på 48 individer fra i fjor.

Sjekk oppdaterte bestandstall og informasjon om jerv på Rovdata.

Jerven kan ved første øyekast minne litt om en liten bjørn. Hannene veier mellom 12 til 18 kilo, mens hunnene er mellom 8 og 12 kilo tunge. De kan bli mellom 70 og 85 centimeter lange og har en buskete hale.

Den kan nedlegge byttedyr som er mange ganger større enn seg selv. Om vinteren spiser jerven hovedsakelig reinsdyr, som den enten har funnet som åtsel eller drept selv.

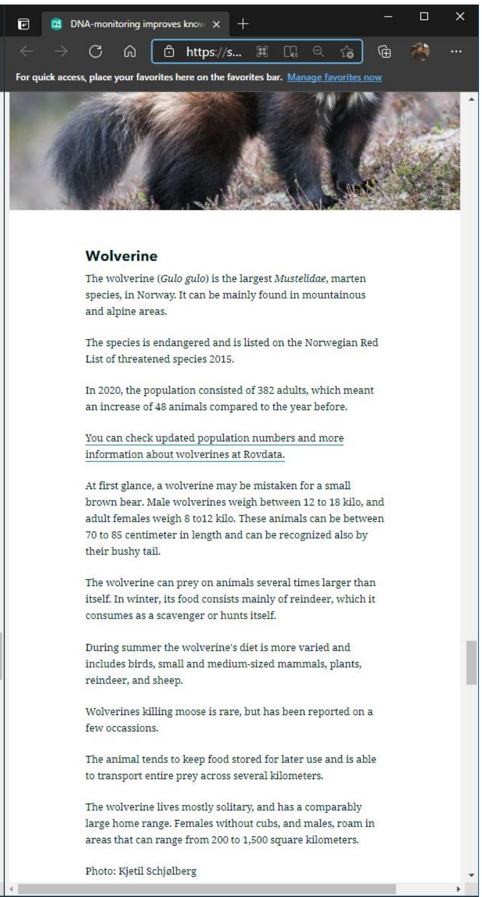
Om sommeren spiser den mer variert og dietten består av fugler, små og mellomstore pattedyr, planter, rein og sau.

Det er til og med noen få kjente tilfeller hvor jerven har tatt elg!

Den lagrer gjerne mat til senere bruk og kan frakte hele byttedyr flere kilometer.

Jerven lever stort sett alene, og har svært store leveområder. Hunner uten unger, og hanner, lever på områder som kan variere fra 200 til 1500 kvadratkilometer.

Foto: Kjetil Schjølberg



Wolverine

The wolverine (*Gulo gulo*) is the largest *Mustelidae*, marten species, in Norway. It can be mainly found in mountainous and alpine areas.

The species is endangered and is listed on the Norwegian Red List of threatened species 2015.

In 2020, the population consisted of 382 adults, which meant an increase of 48 animals compared to the year before.

You can check updated population numbers and more information about wolverines at Rovdata.

At first glance, a wolverine may be mistaken for a small brown bear. Male wolverines weigh between 12 to 18 kilo, and adult females weigh 8 to12 kilo. These animals can be between 70 to 85 centimeter in length and can be recognized also by their bushy tail.

The wolverine can prey on animals several times larger than itself. In winter, its food consists mainly of reindeer, which it consumes as a scavenger or hunts itself.

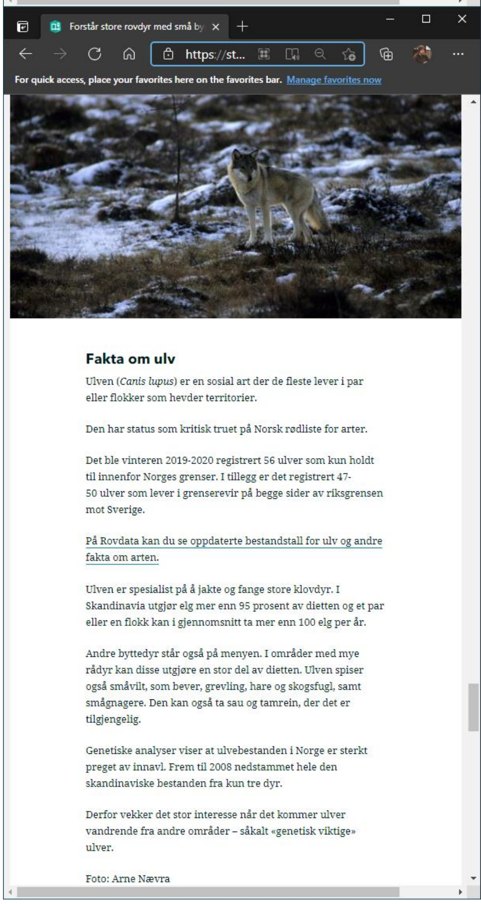
During summer the wolverine's diet is more varied and includes birds, small and medium-sized mammals, plants, reindeer, and sheep.

Wolverines killing moose is rare, but has been reported on a few occassions.

The animal tends to keep food stored for later use and is able to transport entire prey across several kilometers.

The wolverine lives mostly solitary, and has a comparably large home range. Females without cubs, and males, roam in areas that can range from 200 to 1,500 square kilometers.

Photo: Kjetil Schjølberg



Fakta om ulv

Ulven (*Canis lupus*) er en sosial art der de fleste lever i par eller flokker som hevder territorier.

Den har status som kritisk truet på Norsk rødliste for arter.

Det ble vinteren 2019-2020 registrert 56 ulver som kun holdt til innenfor Norges grenser. I tillegg er det registrert 47-50 ulver som lever i grenserevir på begge sider av riksgrensen mot Sverige.

På Rovdata kan du se oppdaterte bestandstall for ulv og andre fakta om arten.

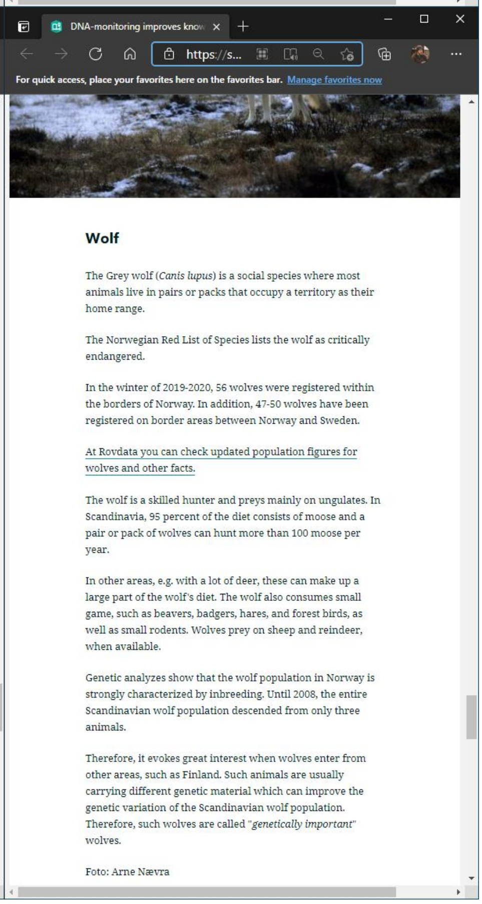
Ulven er spesialist på å jakte og fange store klovdyr. I Skandinavia utgjør elg mer enn 95 prosent av dietten og et par eller en flokk kan i gjennomsnitt ta mer enn 100 elg per år.

Andre byttedyr står også på menyen. I områder med mye rådyr kan disse utgjøre en stor del av dietten. Ulven spiser også småvilt, som bever, grevling, hare og skogsfugl, samt smågnagere. Den kan også ta sau og tamrein, der det er tilgjengelig.

Genetiske analyser viser at ulvebestanden i Norge er sterkt preget av innavl. Frem til 2008 nedstammet hele den skandinaviske bestanden fra kun tre dyr.

Derfor vekker det stor interesse når det kommer ulver vandrende fra andre områder – såkalt «genetisk viktige» ulver.

Foto: Arne Nævra



Wolf

The Grey wolf (*Canis lupus*) is a social species where most animals live in pairs or packs that occupy a territory as their home range.

The Norwegian Red List of Species lists the wolf as critically endangered.

In the winter of 2019-2020, 56 wolves were registered within the borders of Norway. In addition, 47-50 wolves have been registered on border areas between Norway and Sweden.

At Rovdata you can check updated population figures for wolves and other facts.

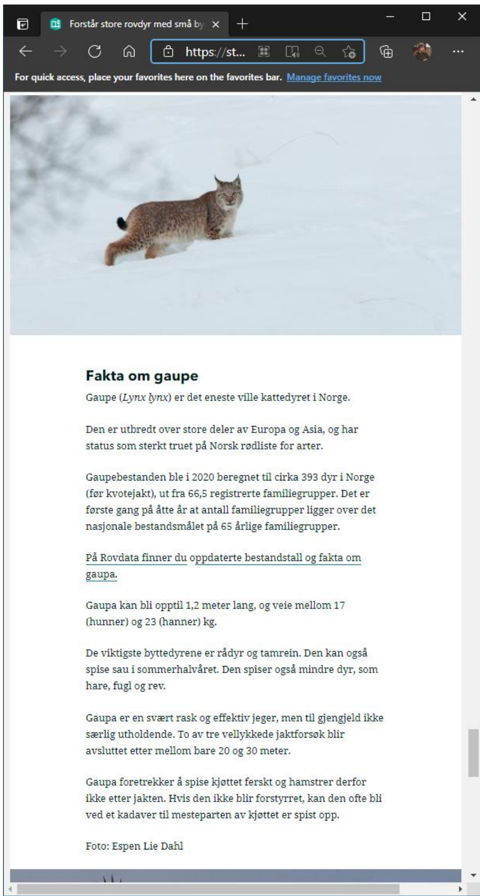
The wolf is a skilled hunter and preys mainly on ungulates. In Scandinavia, 95 percent of the diet consists of moose and a pair or pack of wolves can hunt more than 100 moose per year.

In other areas, e.g. with a lot of deer, these can make up a large part of the wolf's diet. The wolf also consumes small game, such as beavers, badgers, hares, and forest birds, as well as small rodents. Wolves prey on sheep and reindeer, when available.

Genetic analyzes show that the wolf population in Norway is strongly characterized by inbreeding. Until 2008, the entire Scandinavian wolf population descended from only three animals.

Therefore, it evokes great interest when wolves enter from other areas, such as Finland. Such animals are usually carrying different genetic material which can improve the genetic variation of the Scandinavian wolf population. Therefore, such wolves are called "*genetically important*" wolves.

Foto: Arne Nævra



Fakta om gaupe

Gaupe (*Lynx lynx*) er det eneste ville kattedyret i Norge.

Den er utbredt over store deler av Europa og Asia, og har status som sterkt truet på Norsk rødliste for arter.

Gaupebestanden ble i 2020 beregnet til cirka 393 dyr i Norge (før kvotejakt), ut fra 66,5 registrerte familiegrupper. Det er første gang på åtte år at antall familiegrupper ligger over det nasjonale bestandsmålet på 65 årlige familiegrupper.

På Rovdata finner du oppdaterte bestandstall og fakta om gaupa.

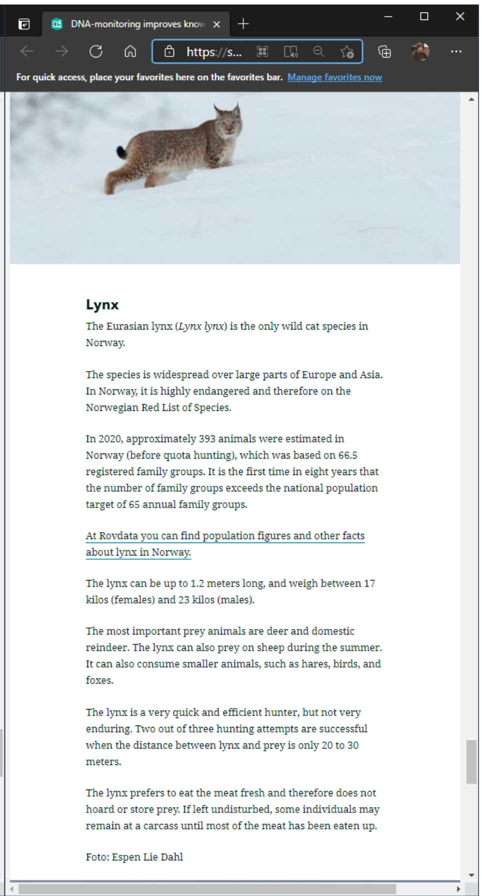
Gaupa kan bli opptil 1,2 meter lang, og veie mellom 17 (hunner) og 23 (hanner) kg.

De viktigste byttedyrene er rådyr og tamrein. Den kan også spise sau i sommerhalvåret. Den spiser også mindre dyr, som hare, fugl og rev.

Gaupa er en svært rask og effektiv jeger, men til gjengjeld ikke særlig utholdende. To av tre vellykkede jaktforsøk blir avsluttet etter mellom bare 20 og 30 meter.

Gaupa foretrekker å spise kjøttet ferskt og hamstrer derfor ikke etter jakten. Hvis den ikke blir forstyrret, kan den ofte bli ved et kadaver til mesteparten av kjøttet er spist opp.

Foto: Espen Lie Dahl



Lynx

The Eurasian lynx (*Lynx lynx*) is the only wild cat species in Norway.

The species is widespread over large parts of Europe and Asia. In Norway, it is highly endangered and therefore on the Norwegian Red List of Species.

In 2020, approximately 393 animals were estimated in Norway (before quota hunting), which was based on 66.5 registered family groups. It is the first time in eight years that the number of family groups exceeds the national population target of 65 annual family groups.

At Rovdata you can find population figures and other facts about lynx in Norway.

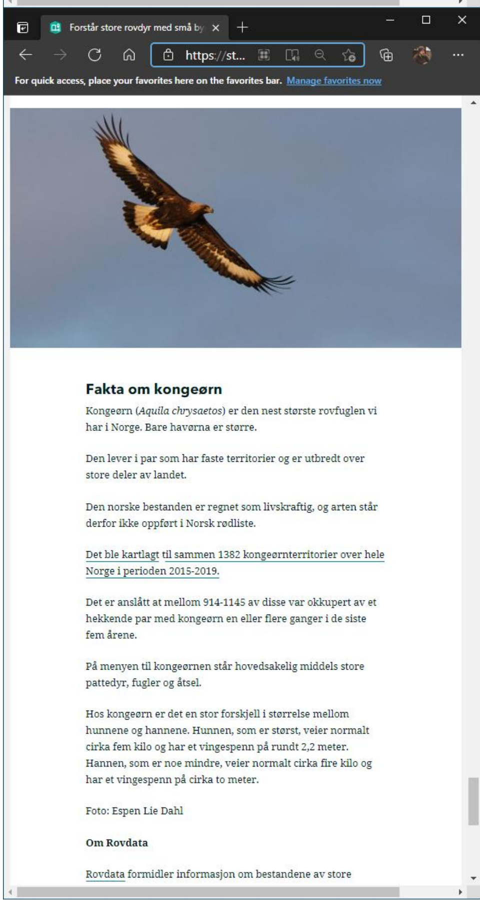
The lynx can be up to 1.2 meters long, and weigh between 17 kilos (females) and 23 kilos (males).

The most important prey animals are deer and domestic reindeer. The lynx can also prey on sheep during the summer. It can also consume smaller animals, such as hares, birds, and foxes.

The lynx is a very quick and efficient hunter, but not very enduring. Two out of three hunting attempts are successful when the distance between lynx and prey is only 20 to 30 meters.

The lynx prefers to eat the meat fresh and therefore does not hoard or store prey. If left undisturbed, some individuals may remain at a carcass until most of the meat has been eaten up.

Foto: Espen Lie Dahl



Fakta om kongeørn

Kongeørn (*Aquila chrysaetos*) er den nest største rovfuglen vi har i Norge. Bare havørna er større.

Den lever i par som har faste territorier og er utbredt over store deler av landet.

Den norske bestanden er regnet som livskraftig, og arten står derfor ikke oppført i Norsk rødliste.

Det ble kartlagt til sammen 1382 kongeørnterritorier over hele Norge i perioden 2015-2019.

Det er anslått at mellom 914-1145 av disse var okkupert av et hekkende par med kongeørn en eller flere ganger i de siste fem årene.

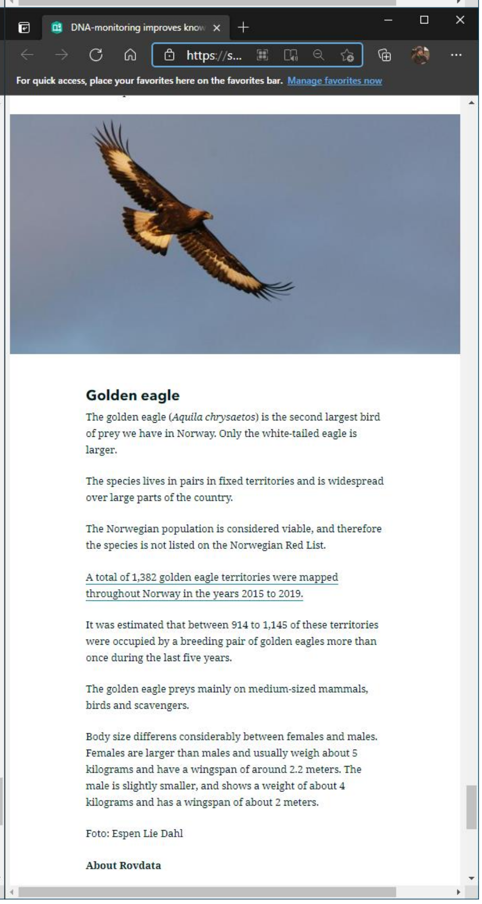
På menyen til kongeørnen står hovedsakelig middels store pattedyr, fugler og åtsel.

Hos kongeørn er det en stor forskjell i størrelse mellom hunnene og hannene. Hunnen, som er størst, veier normalt cirka fem kilo og har et vingespenn på rundt 2,2 meter. Hannen, som er noe mindre, veier normalt cirka fire kilo og har et vingespenn på cirka to meter.

Foto: Espen Lie Dahl

Om Rovdata

Rovdata formidler informasjon om bestandene av store



Golden eagle

The golden eagle (*Aquila chrysaetos*) is the second largest bird of prey we have in Norway. Only the white-tailed eagle is larger.

The species lives in pairs in fixed territories and is widespread over large parts of the country.

The Norwegian population is considered viable, and therefore the species is not listed on the Norwegian Red List.

A total of 1,382 golden eagle territories were mapped throughout Norway in the years 2015 to 2019.

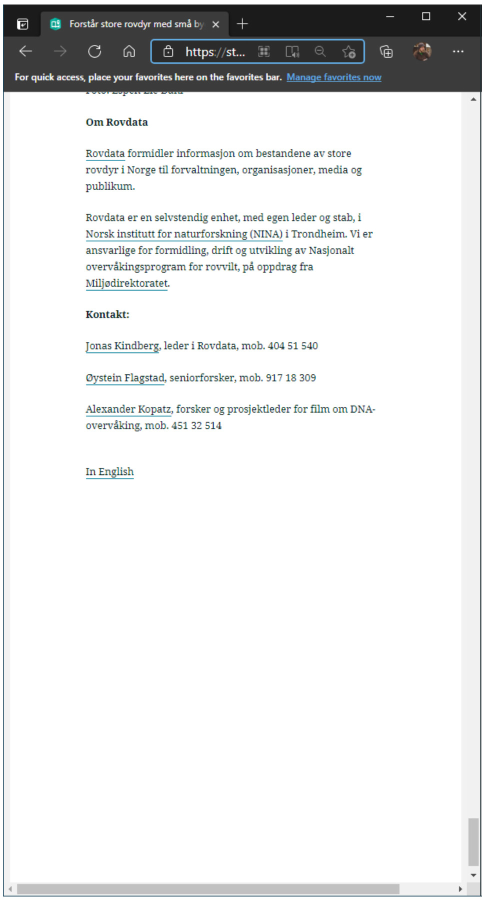
It was estimated that between 914 to 1,145 of these territories were occupied by a breeding pair of golden eagles more than once during the last five years.

The golden eagle preys mainly on medium-sized mammals, birds and scavengers.

Body size differens considerably between females and males. Females are larger than males and usually weigh about 5 kilograms and have a wingspan of around 2.2 meters. The male is slightly smaller, and shows a weight of about 4 kilograms and has a wingspan of about 2 meters.

Foto: Espen Lie Dahl

About Rovdata



Forstår store rovdyr med små by

For quick access, place your favorites here on the favorites bar. Manage favorites now

Om Rovdata

Rovdata formidler informasjon om bestandene av store rovdyr i Norge til forvaltningen, organisasjoner, media og publikum.

Rovdata er en selvstendig enhet, med egen leder og stab, i Norsk institutt for naturforskning (NINA) i Trondheim. Vi er ansvarlige for formidling, drift og utvikling av Nasjonalt overvåkingsprogram for rovvilt, på oppdrag fra Miljødirektoratet.

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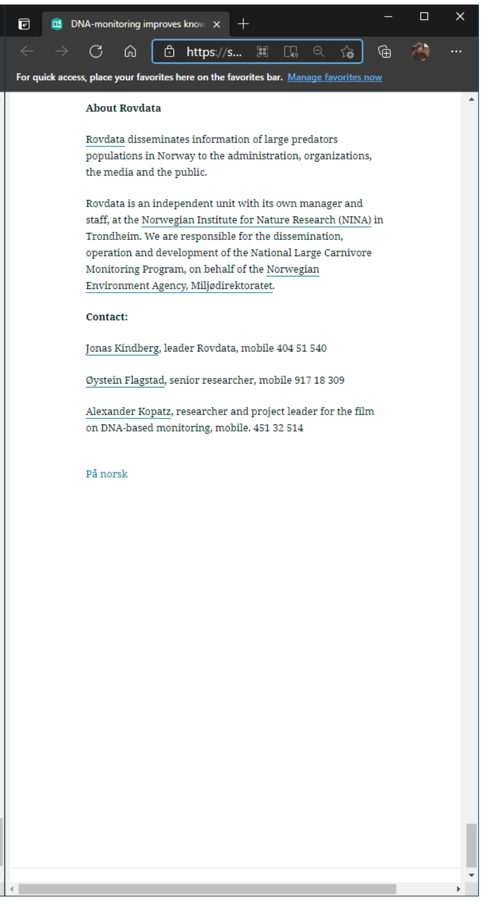
Øystein Flagstad, seniorforsker, mob. 917 18 309

Alexander Kopatz, forsker og prosjektleder for film om DNA-overvåking, mob. 451 32 514

In English



DNA-monitoring improves know

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About Rovdata

Rovdata disseminates information of large predators populations in Norway to the administration, organizations, the media and the public.

Rovdata is an independent unit with its own manager and staff, at the Norwegian Institute for Nature Research (NINA) in Trondheim. We are responsible for the dissemination, operation and development of the National Large Carnivore Monitoring Program, on behalf of the Norwegian Environment Agency, Miljødirektoratet.

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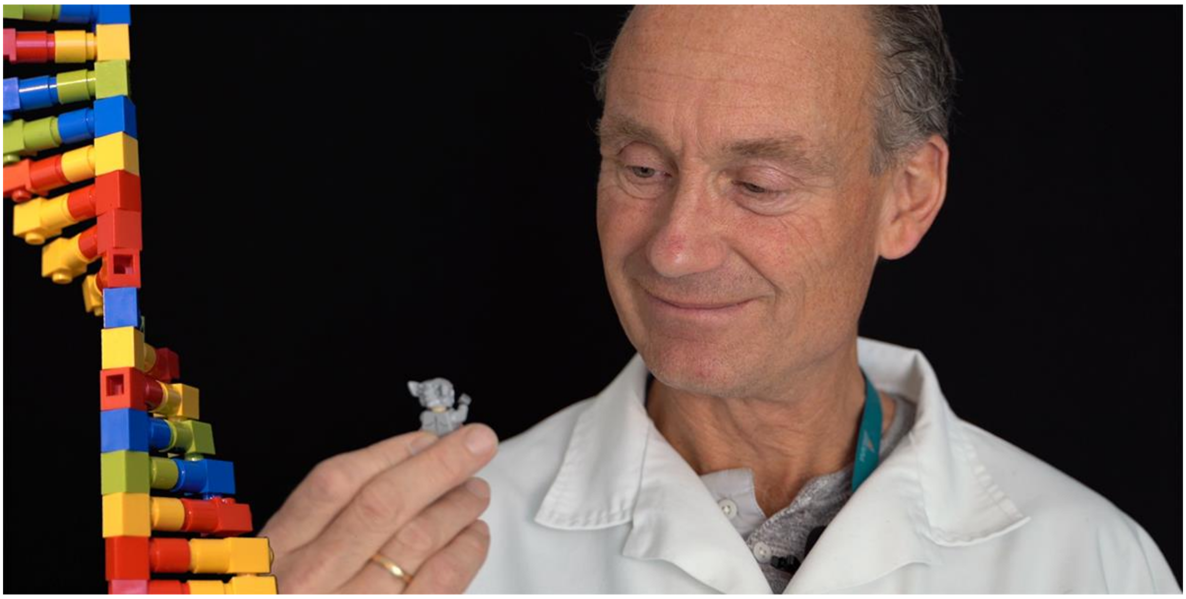
På norsk

10.2 Press release

DNA er et genialt verktøy i rovviltovervåkingen

Publisert 04.02.2021

DNA er mye diskutert i rovviltdebatten i Norge. Rovdata har derfor lansert en ny film og nettside som forklarer hvordan vi bruker DNA til å overvåke de store rovdyrene og kongeørn i landet.



Øystein Flagstad forklarer hva DNA er på en enkel og god måte. Foto: Rovdata

Ved hjelp av DNA kan vi kartlegge rovdyrene, finne skadegjørere og oppdage genetisk viktige individer. DNA er oppskriften på livet rundt oss og siden alt levende har en unik DNA-profil, gir det store muligheter for forskning på, og overvåking, av naturen.

Vi finner DNA i skit, hår, urin og fjær som dyrene har etterlatt seg i naturen. Det tas også vevsprøver av døde dyr, og det analyseres årlig noen spyttprøver fra bittmerker på døde beitedyr.

Forklarer DNA i ny film

Rovdata og Norsk institutt for naturforskning (NINA) viser i en ny film hvordan DNA brukes til å overvåke rovdyr i Skandinavia. Filmen er finansiert av Miljødirektoratet.

Det pågår i dag en årlig landsomfattende innsamling av DNA-prøver fra ulv, brunbjørn og jerv, og det tas også fjærprøver fra kongeørn i utvalgte områder. I to tiår er det samlet inn DNA fra de store rovdyrene, og resultatene er lagt i en felles skandinavisk database. Rovbase.no inneholder informasjon om godt over 100 000 DNA-prøver fra ulv, bjørn, jerv, gaupe og kongeørn.

– DNA er genialt og enkelt og gir enorme muligheter i overvåking av naturen. Dette ønsket vi å informere om i en film lagd for et publikum i alle aldersgrupper. Vi kan telle rovdyrene, få kunnskap om hvor de vandrer og hvilke områder de bruker, samt følge individer over flere år, fastslå slektskap og en rekke andre ting. Alle kan også bidra ved å samle inn skit og hår uten å være i kontakt med dyrene, sier Alexander Kopatz i Rovdata.

Premiere i dag!

Kopatz er prosjektleder for filmen som har premiere i dag. I filmen følger vi ei skandinavisk ulvetispe som møter en hannulv fra Finland. I løpe av filmen får vi høre fra Statens naturoppsyn, Miljødirektoratet, Rovdata og internasjonale forskere om hva DNA er og hvordan vi bruker DNA til å overvåke ulvene og andre arter som brunbjørn og jerv.

Filmen presenterer grunnleggende informasjon for at folk bedre skal forstå hvordan vi bruker DNA i overvåkingen, men også noen av utfordringene knyttet til metoden.

– For oss i forvaltningen er det viktig at publikum forstår kunnskapen vi benytter. DNA kan være utfordrende for de aller fleste å skjønne fullt ut, og derfor kan en film som dette bidra til å forklare på en lettfattelig og god måte, forklarer Siv Grethe Aarnes i Miljødirektoratet.

Alle kan bidra

Alle kan bidra i DNA-innsamlingen på brunbjørn, jerv og ulv. Det eneste du trenger er en ren plastpose eller en konvolutt for hårprøver. Du skal levere prøver til din lokale rovviltkontakt i SNO (lenke).

– Alle kjente rovdyr er registrert i en felles skandinavisk database (www.rovbase.no), der publikum kan gå inn og sjekke analyseresultat fra innleverte DNA-prøver, forklarer Kopatz.

NINA bruker også DNA til å følge med på laks, liv i innsjøer, og en rekke andre dyr.
Les mer om bruken av DNA i overvåkingen av de store rovdyrene på www.rovdata.no/dna.

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www.nina.no

1999

NINA Report

The Norwegian Institute for Nature Research, NINA, is as an independent foundation focusing on environmental research, emphasizing the interaction between human society, natural resources and biodiversity.

NINA was established in 1988. The headquarters are located in Trondheim, with branches in Tromsø, Lillehammer, Bergen and Oslo. In addition, NINA owns and runs the aquatic research station for wild fish at Ims in Rogaland and the arctic fox breeding center at Oppdal.

NINA's activities include research, environmental impact assessments, environmental monitoring, counselling and evaluation. NINA's scientists come from a wide range of disciplinary backgrounds that include biologists, geographers, geneticists, social scientists, sociologists and more. We have a broad-based expertise on the genetic, population, species, ecosystem and landscape level, in terrestrial, freshwater and coastal marine ecosystems.

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NINA

Cooperation and expertise for a sustainable future