Herding on Thin Ice

An exercise in resiliance and adaptive strategy

By: Tracie Curry
MLA 2013

Special thanks to the researchers at the International Center for Reindeer Husbandry, who provided invaluable knowledge and guidance throughout this effort and without whom this thesis would not be possible. Thanks also to the loving support of my family and friends.

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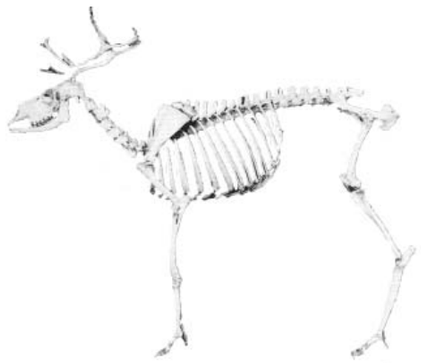


Abstract

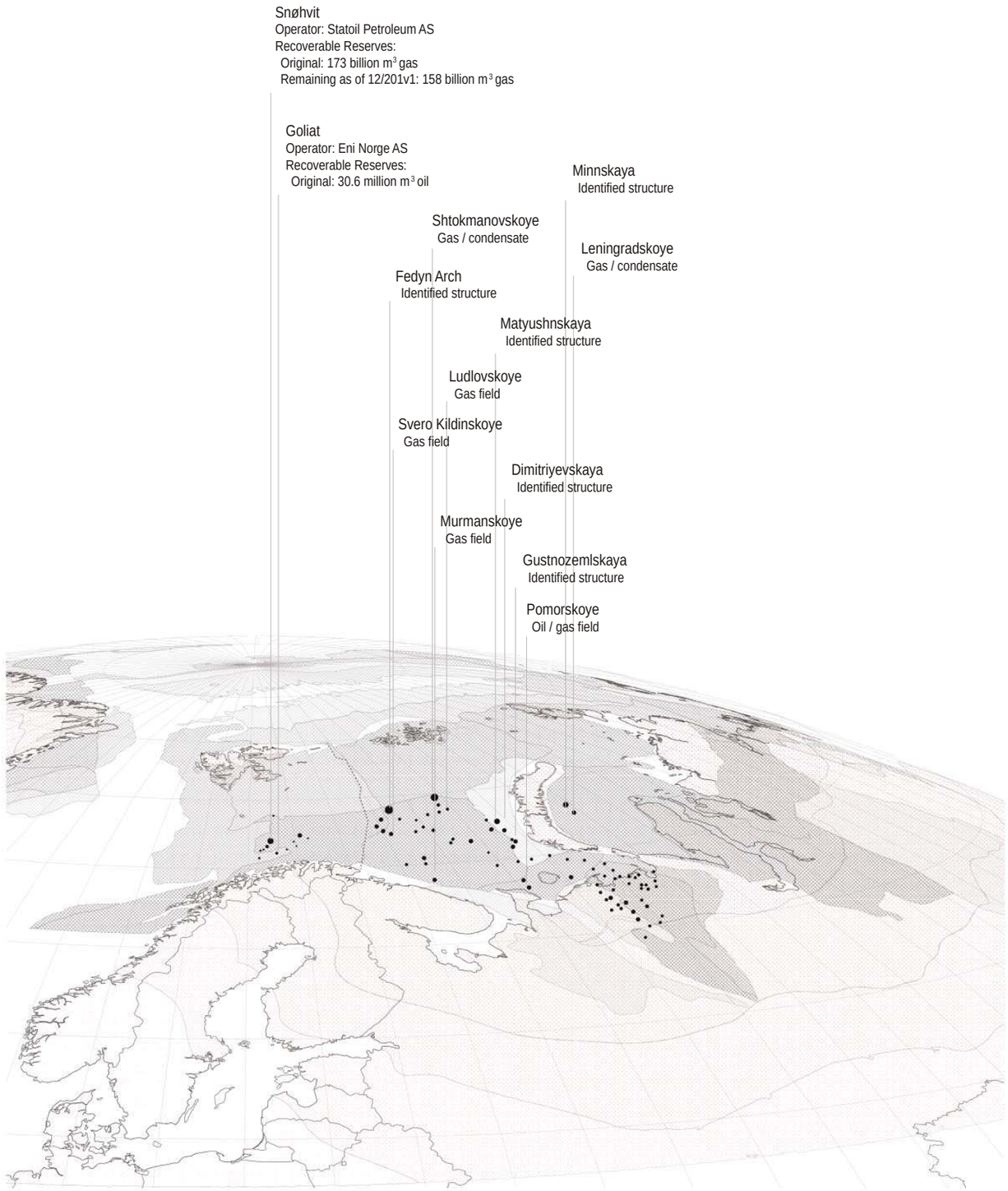
Indigenous populations of the north have practiced reindeer husbandry as a livelihood for over one thousand years. These nomadic peoples live with a particular relationship to the land, which is transforming due to the effects of climate change and increased human activity in the region, including mining and urban expansion. This project explores strategies to facilitate the coexistence of global industry and local reindeer husbandry in the changing Arctic climate. Its primary goal is to ensure the survival of this traditional livelihood by optimizing reindeer nutrition, fertility and mobility in increasingly adverse conditions. To this end, the project will suggest a framework for the spatial organization of industrial activities to ensure minimal impact on reindeer husbandry throughout their operation as well as strategies for the productive reuse of these degraded sites after decommissioning. Connectivity in relation to herders' nomadic patterns and industrial flows is another major theme underpinning this project, which necessitates the design and organization of infrastructural systems. These might include strategically placed corridors and crossings, roads and shipping networks. Approaching these issues from a landscape architecture perspective incorporates a wider range of knowledge and insights into the standardized solutions accepted today. The external factors affecting the site, including climate change and volatile global markets, ensure constantly fluctuating conditions and obviate the usefulness of any static state solution, thus making adaptability and resilience inherent drivers of the project strategy. To explore these topics, I will use the case of Hammerfest, located on Kvaløya Island in the Finnmark region of northern Norway where families of herders are currently struggling to maintain their traditions in the face of multiple development threats.

Right: Rock art in Alta, Norway, carved at varying periods between 7,000 and 2,000 years in the past.

Thesis Statement

Introduction

This project explores applications for landscape architecture strategies in facilitating the coexistence of industry and nomadic Sámi reindeer husbandry in the changing arctic climate. Its primary goal is to ensure the survival of husbandry as a traditional livelihood by optimizing reindeer nutrition, fertility and mobility in increasingly adverse conditions. This topic fits well within the field of landscape architecture due to the regional scale at which the issues operate as well as the project's inherent basis in culture, ecology, seasonality and temporality, which are all addressed in landscape strategy. Currently, landscape architects are rarely invited to weigh in on regional scale issues, which are influenced at the multi-national level increasingly by NGOs and other advocacy groups (Swaffield, 2012). However, in the interest of cultural and ecological sustainability, there is no doubt that this is an arena in which we are needed as our concerns are not only with the performance based aspects of environmental systems, but also with their social context and their connection to larger regional scale settlement patterns. A primary goal of the proposed study is to improve decision making tools that inform Arctic planning and development decisions. By addressing multiple and interacting stresses and with an emphasis on the full range of relevant time and spatial scales affected by climate change, this study furthers standard vulnerability assessment methodology, which is typically performed on a one-off basis, addressing only a narrow subset of potential influences (McCarthy, 2004). Furthermore, considering the projected timeframe for global climate change and associated development, now



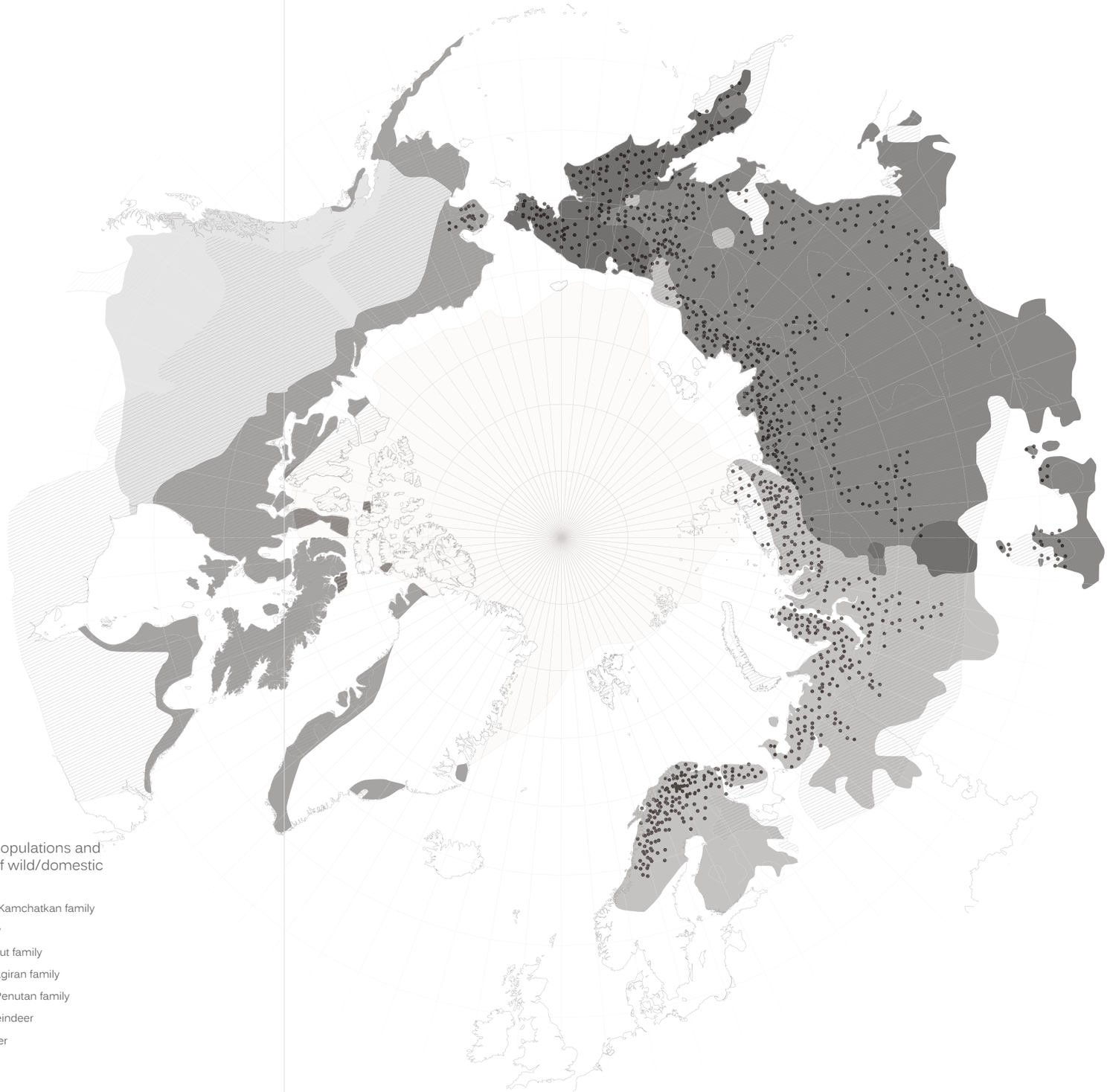
Right: Arctic oil / gas potential

- < 10% probability
- 10 - 30% probability
- 30 - 50% probability
- 50 - 100% probability
- 100% probability

is the optimal time to begin addressing these issues. For reindeer herders, the negative impacts of climate change are already apparent in increasingly variable weather and shortened snow seasons. However, more substantial changes are imminent. The most conservative estimates project an ice free arctic will occur between 2070 and 2100, while some scientists believe this could happen as soon as 2030 (Magga 2011). This has positive implications for global shipping, offshore drilling, and coastal development in the arctic, which translates to increased human presence, environmental disturbance and competition for traditional pasture land. Additionally, warming temperatures are contributing to changing weather patterns and more lengthy spring and fall seasons. Among other things, this affects the distribution of northern vegetation, snow quality and seasonal melt patterns, which are all integral components of husbandry practice (Oskal et al. 2009). Given the drastic changes that are likely to become realized within the next 20 years, there is currently a unique opportunity to begin developing and implementing adaptive solutions in their anticipation (Magga 2011).

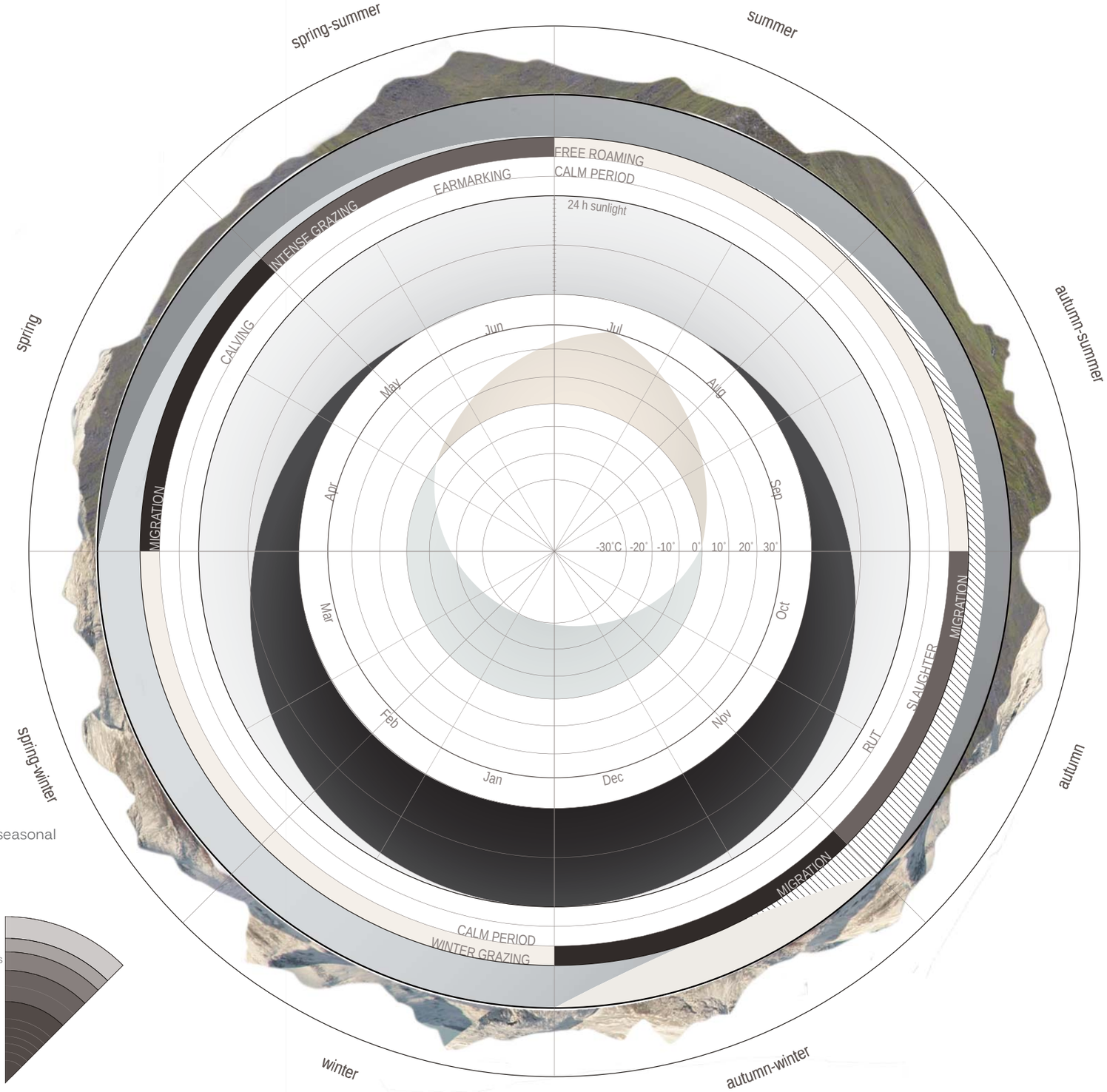
Reindeer Husbandry

The term husbandry refers to the possession, maintenance and management of a herd which is the harvestable resource of its owners (Tyler, Turi and al 2007). Humans have depended on reindeer for thousands of years in the northern hemisphere. Bones and antlers in Western Europe have been discovered, dating back to between 11,000 and 18,000 years, when the ice sheets retreated from this region. Likewise, in North America, evidence of hunting camps has been unearthed between Michigan and Ontario dating back 11,000 years. Today, the range of reindeer is restricted to arctic territories where it is estimated that 3 million wild and 2.5 million domesticated reindeer exist. Native peoples in Canada and Alaska hunt wild Caribou. The peoples of the American continents never domesticated reindeer and, apart from a few Siberian animals introduced in Alaska during the 1890s, only wild reindeer exist. Both wild and domesticated reindeer can be found in northern Russia, Scandinavia and the northwestern mountains of Mongolia. There are approximately 1.2 million domesticated reindeer in Russia with a grazing range of approximately 3.4 million square kilometers (2002), nearly one fifth of the country's land area (Vitebsky 2006). In Sapmi, northern Finland, Sweden and Norway, there are about a half million domesticated reindeer in a range of 414,000 square miles (Jernsletten and Klokov 2002).



Migration

Of the Pleistocene large animals that were hunted for food, only elk, muskoxen and reindeer have survived and, out of this group, only reindeer, rangifer tarandus, flourish in large numbers. This is partly due to their exceptional adaptation to cold and powerful migratory instinct (Vitebsky 2006). During their spring migration they follow the succession of green plants sprouting in the wake of seasonal snow melt, which traditionally occurs from May onward. The route stretches from the inland shelter of their tree line winter home, upstream through valleys in the spring and to higher elevations in the summer where mountain patches of snow allow the reindeer to cool down and escape from bugs. Higher grounds also provide fresh grass as the snow melts, with the newest growth being the most nutritious. In the autumn, mushrooms become an important part of their diet and, as green pastures wither in the cold, the animals are increasingly dependent on lichens (Eira 2012).
The reindeer herders are present in partnership with reindeer throughout all of these periods with their own seasonal activities coinciding with migratory events. They protect the animals from predators throughout the year and assist during calving season in the early spring. The autumn-winter slaughtering season is an important time to determine herd structure, which animals should be slaughtered and which should be used for breeding. They also orchestrate the collection and dispersal of the herd before and after migration (Jernsletten and Klokov 2002).



Right: Sámi seasonal calendar

Site Description

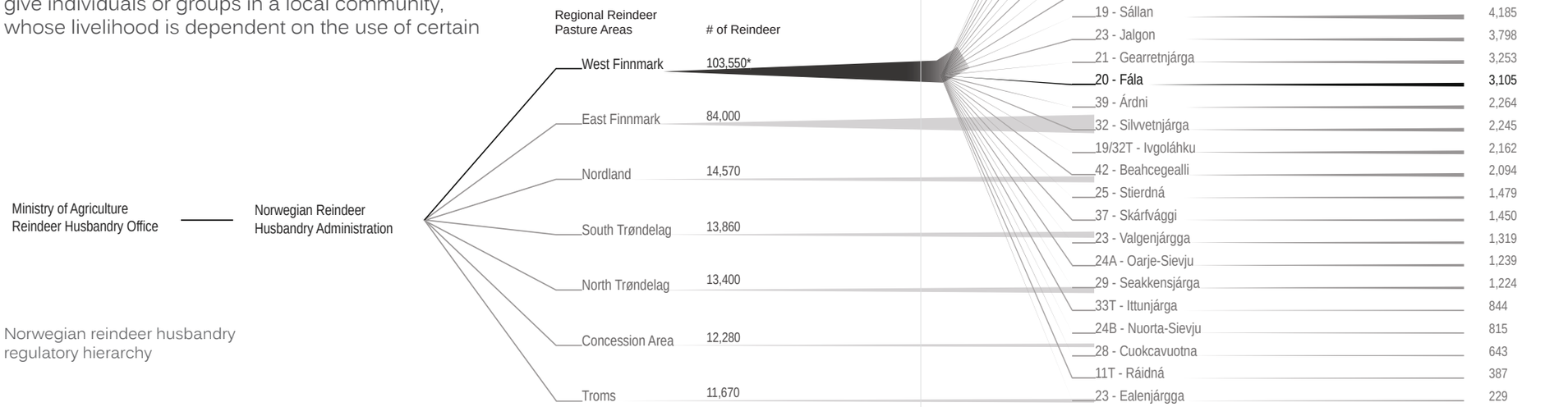
The Sámi in Norway and the Legacy of Nomadic Pasture Commons:

Northern native peoples inhabiting the harshest and most marginal regions share a common history in that colonization of these areas was never completed to the extent that it was in mainland areas, allowing these groups to maintain much of their lifestyle and customary use of natural resources (Sandberg 2008). From 1328 to 1852, the national borders between Norway, Sweden, Finland and Russia were not well-defined and Sámi reindeer herders moved their herds freely between territories claimed by separate nation states. While sedentary Sámi were gradually assimilated into Norwegian, Sweedish and Finnish culture beginning in the 1750s, the nomadic Sámi were not affected until 1852, when the borders between Norway, Sweden and Finland were closed to Sámi reindeer migrations. This was the start of a period of 'Norwegianization' of the Sámi through a series of policies that suppressed Sámi cultural heritage and a national compulsory schooling system that forbade the use of the Sámi language (Sandberg 2008).

In Norway, approximately 240,000 semi-domestic reindeer are herded over an area of 146,000 square kilometers, which is about 40 percent of the country's mainland area. Of the approximately 10,000 Sámi persons listed in the electoral register in Norway (2005) about 2,900 practice reindeer husbandry. In Norway, the Sámi exclusively, with the exception of one concession area, are allowed to practice reindeer husbandry under the Norwegian Reindeer Herding Act of 1978. Norway consists of six Reindeer Pasture Areas, East Finnmark, West Finnmark, Troms, Nordland, North Trondelag and South Trondelag/Hedmark, with Finnmark containing the largest concentration of reindeer herders. These areas are in turn divided into 90 Reindeer Pasture Districts, which are internally subdivided according to seasonal migratory patterns. Several operational units (driftsenhet) are authorized to operate within these districts. The structure of the operational unit parallels the Sámi concept of "Siida" (community), which is the traditional organizational unit of reindeer owners

Right: Norwegian herding districts, offshore hydrocarbon exploration leases and onshore mineral resources

and their families (Sara). (Jernsletten and Klokov 2002).
The Sámi people have traditionally held land in common, with each Siida having equal rights and access to the land in their district. These 'reindeer commons' rights largely remain valid in Finnmark despite 300 years of state ownership. While the state is responsible for the overall management of grazing rights in Norway, the legal base for Sámi reindeer husbandry is ancient indigenous land use, not contemporary law. Therefore, the right to reindeer grazing is a collective right, which all Sámi herders have a claim in (Sandberg 2008).
The process of institutionalizing Sámi local rights has taken place over a 30-year period beginning in 1978 when the Sámi organized in mass to protest a hydroelectric dam project across the Alta River, which threatened to inundate traditional grazing lands. In addition to a constitutionally recognized independent Sámi state and national Sámi Parliament (1987), a 2004-2005 law established the Finnmarkseiendommen as an independent owner-body to which the Norwegian state transferred all its property rights to land, lakes and rivers in Finnmark. The Finnmarkseiendommen is governed by a board of equal members from the Sámi Parliament (3) and from the Provincial Council of Finnmark (3). A key principal of the law is that collective rights can exist alongside individual rights and that both should be allowed to develop in a dynamic fashion. The Finnmarkseiendommen develops general guidelines for local municipalities, which in turn can give individuals or groups in a local community, whose livelihood is dependent on the use of certain local resources, the right to utilize these for 10 years at a time (Sandberg 2008).
The motivation of the state to decentralize control of natural resources is partly based on a need to make amends for historical injustices to the Sámi and partly in an effort to replace costly centralized governing with local institutions that are legitimate, efficient, flexible and self-governing. However, underlying these efforts remains an imperative to maintain a fundamental balance between the political duty to make amends to the Sámi and the continued legitimacy of the institutional governing body. Additionally, the need for securing the material base for the traditional indigenous culture cannot override the growth of resource-based economic activities upon which local municipalities are depending to modernize and develop according to market changes (Sandberg 2008).

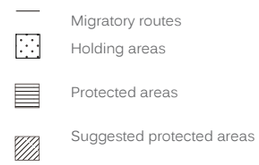


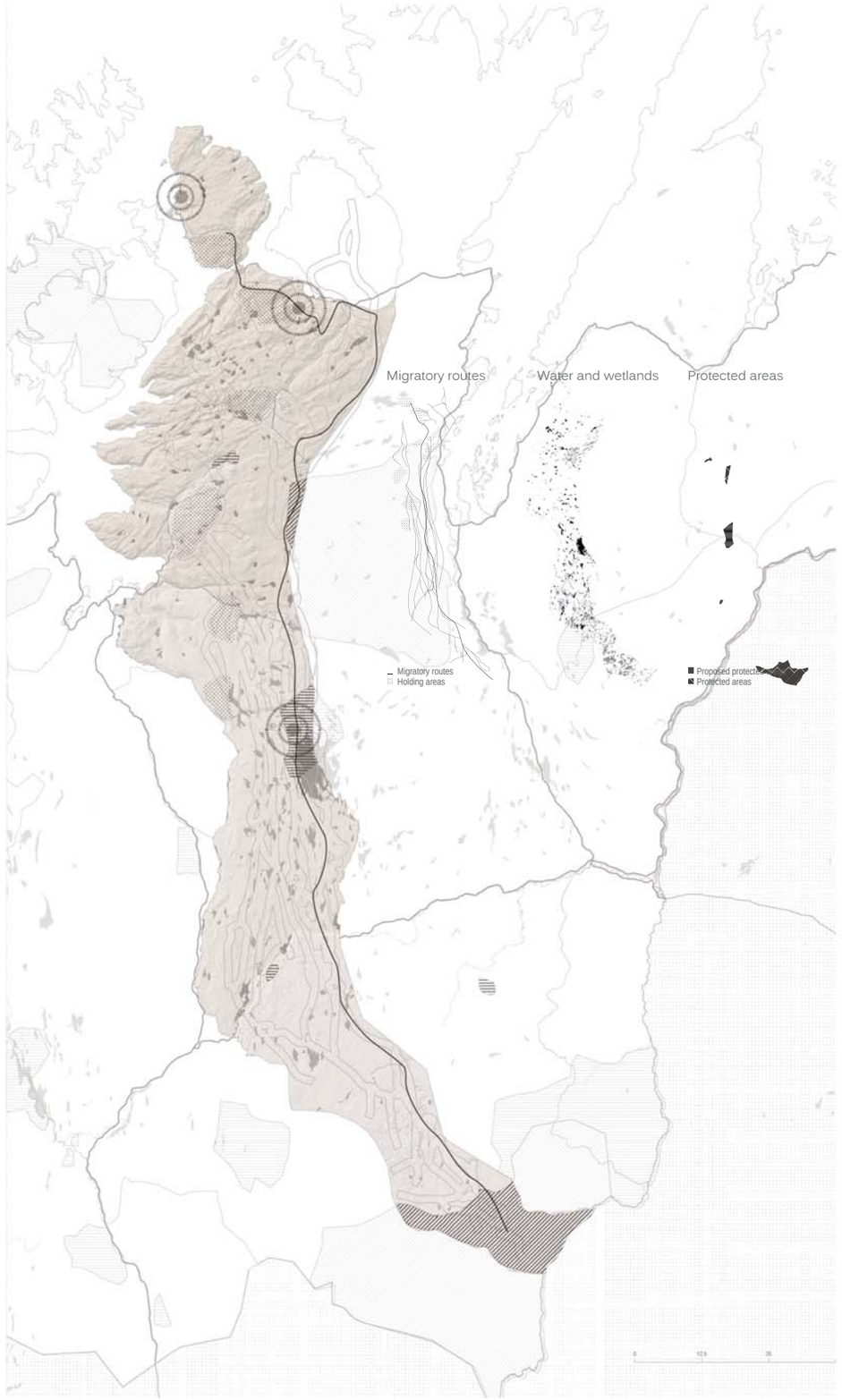
Norwegian reindeer husbandry regulatory hierarchy

Finnemark Mineral and Hydrocarbon Extraction Activity:

The oil and gas resources in Finnmark are found only offshore, but activities related to their exploration, extraction and processing generate infrastructure and other development projects onshore in reindeer grazing areas. A combination of offshore oil and gas production, mining, hydro electric dams, power lines, wind power and residential development stand in direct competition with traditional reindeer herding land use, particularly in the summer pastures and calving grounds of Finnmark (Vistnes 2009).
Fálá, Reindeer District 20, is one of the most significantly affected by the abovementioned development activities. Fálá moves its reindeer directly south of a proposed copper mine in the spring and, if opened, the mine is likely to obstruct their traditional route (Nellman and Ims Vistnes 2011). This would result in increased travel distances during the particularly sensitive calving season. Furthermore, Fálá's summer pastures are on Kvaløya Island, where production facilities linked to offshore natural gas (existing) and oil fields (proposed) are based in the city of Hammerfest.
In addition to the industrial facilities themselves, economic growth driven by these activities has also resulted in increased pressure for housing and commercial development throughout the island. Additional projects affecting herding include the proposed construction of a windmill farm with a total of 102 windmills and a 420 Kv powerline. All the aforementioned activities interfere with grazing and obstruct access to sites of cultural importance which are rarely considered in proposed development plans. Furthermore, conflicts in the form of highway accidents and reindeer intrusions onto private property are becoming more frequent as urban and faunal territories increasingly overlap (Magga 2011)

Right: Fála (district 20) migratory route





Residential expansion

Radio Station

Gravel pit

Snowmobile course

Snohvit planned extension

Underground powerline

Residential

Skiing / hiking trail

Industrial area

Goliat transformer station

Snohvit tunnel to island

Residential expansion

Snohvit

Aboveground powerline

Reindeer fence

Residential expansion

Windmill park

New industrial area

Residential expansion

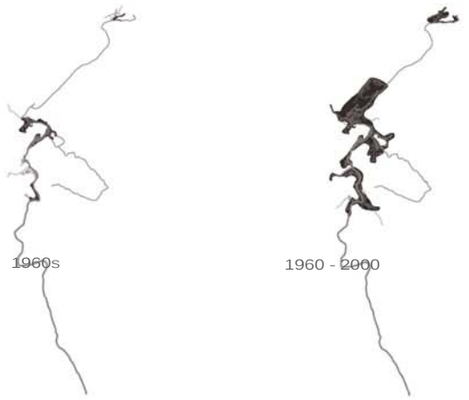
Industrial zone

New airport

Residential expansion

Kvaløya development growth

- 1960s
- 1960 - 2000
- 2000 - 2012 (current)
- Planned development



Climate Change:

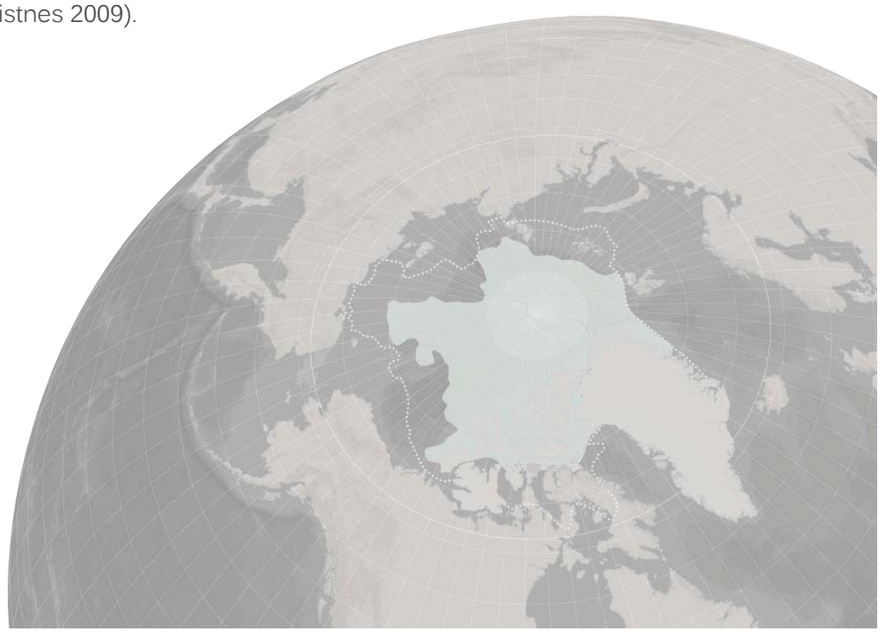
Climate change is having a significant impact on the arctic environment and on traditional lifestyles. In September 2012, Arctic sea ice extent reached a historical low of 3.4 million square kilometers since the beginning of satellite measurements in 1979 (Arctic Portal 2012). Compared to September conditions in the 1980s and 1990s, this represents a 45 percent reduction in ice coverage. Evidence indicates that, along with declining sea ice, the effects of climate change are contributing to changes in fisheries and ecosystems, increased shipping activity, and increased oil and gas extraction activities in the region. Among the numerous stakeholders affected by these changes, the Arctic's native inhabitants are perhaps the most vulnerable. Changes in snow and ice cover in addition to temperature increases have already begun to affect reindeer husbandry. Temperature changes influence freeze-thaw cycles, causing some rivers to freeze later in the autumn and melt earlier in the spring and resulting in challenges for the annual migration of reindeer through different pastures (Eira, 2012). Greater climate variability at the local level has also been observed. This is especially critical during the winter where increasingly mild weather, accompanied by rain, is followed by colder periods, which result in the formation of impenetrable ice layers in the snow that block reindeers' access to food on the ground. Increased insect harassment accompanying warmer temperatures is another major factor that negatively affects foraging (Maynard, Oskal and al 2010).

Declining sea ice and longer summers are leading to the increased accessibility of arctic regions and, consequently, increased human presence. Growing development activity is a threat to reindeer husbandry as competition for land use results in a direct loss of pasture resources. In addition to physical destruction resulting from development, loss of pasture also occurs through a reduction in use as land within the vicinity of development and human activity is gradually abandoned by reindeer. For example, female reindeer and calves are especially sensitive and have been shown to avoid areas much greater than the immediate development footprint. A number of studies have documented a 50 to 95 percent reduction in the use of rangeland by reindeer within a 2.5 to 5 kilometer zone surrounding development (Vistnes 2009). Estimates indicate that, in the last 50 years, approximately 25 percent of reindeer pastures in the Euro-Arctic Barents region have been lost in this way (Maynard, Oskal and al 2010).

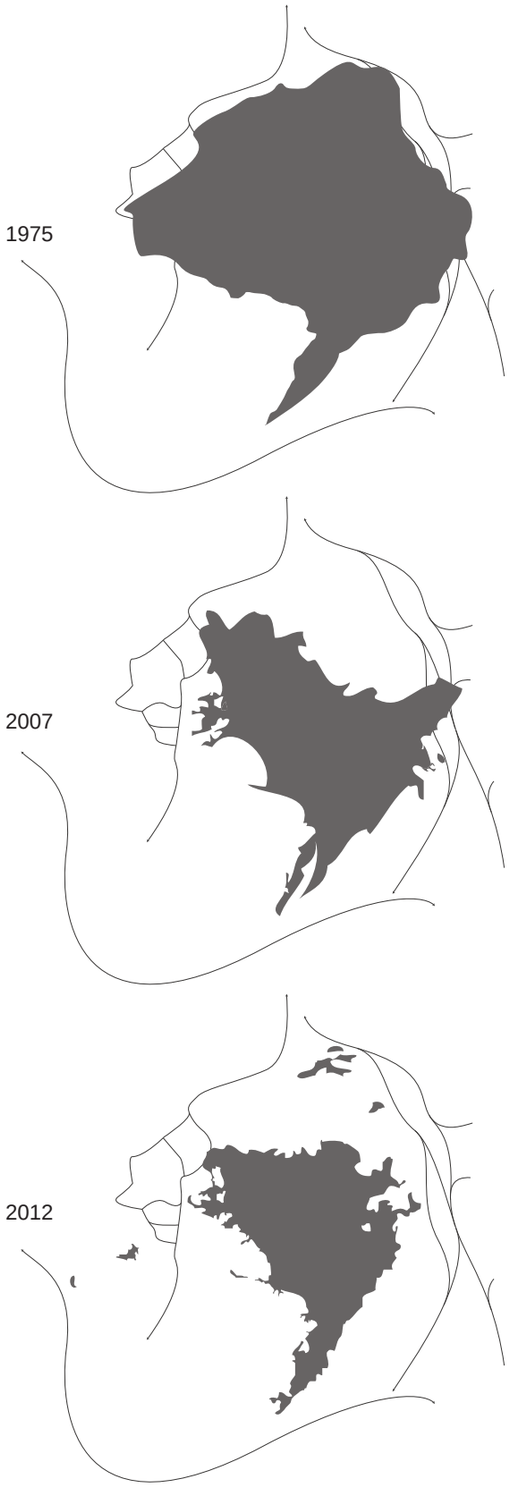
Climatic variability is nothing new and reindeer herders have overcome periods of dramatic fluctuation in the past, which demonstrates their skill and versatility in exploiting the options available within their diverse landscape. However, it is the combination of climate change and reduced available pasture area that creates a new and more severe challenge.

"The more landscape types one has – that is alternatives to meet different situations – the more secure reindeer pastoralism will be over a longer period of time. Contrariwise, in a uniform landscape without alternatives, one is left helpless when faced with natural changes" (Mikkel Nils Sara quoted in (Tyler, Turi and al 2007)).

For this reason loss of pasture is regarded by many as the largest threat to reindeer husbandry. In particular, reindeer herding areas of northern Scandinavia have seen more extensive development and government intervention than most other reindeer herding regions of the world (Vistnes 2009).



Right: change in summer arctic ice extent from 1979 to 2002



Left: change in summer arctic ice extent from 1979 (beginning of data collection) to 2007 (previous low) to 2012 (current low)

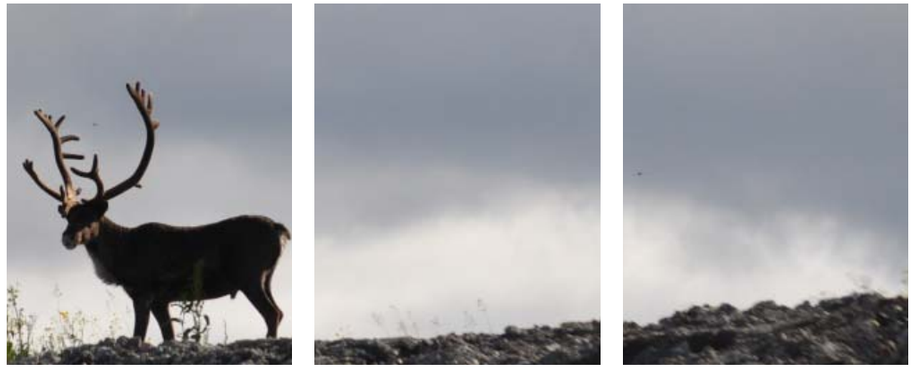
Right: Environmental sensitivity to climate change

Jassa: Snow that persists into the summer. Critical to cool reindeer in warm weather and, often times, acting as a bridge across otherwise impassible terrain.

Damage from birch caterpillar, which thrives in warmer weather

A Way Forward:

The survival and long term sustainability of reindeer husbandry depends on the development of adaptation and mitigation strategies planning for the future that focus on both the immediate and long term effects of climate change and development. These strategies might involve the identification or creation of alternate grazing ranges, the restoration of current ranges, or the development of mitigation schemes to reduce the impacts of current and planned activities (Vistnes 2009). Through the application of methods developed within the discipline of landscape architecture, this project seeks to develop strategies that ensure flexible access to pastures and migration routes able to co-exist with increasing development in a changing climate.



Precedent

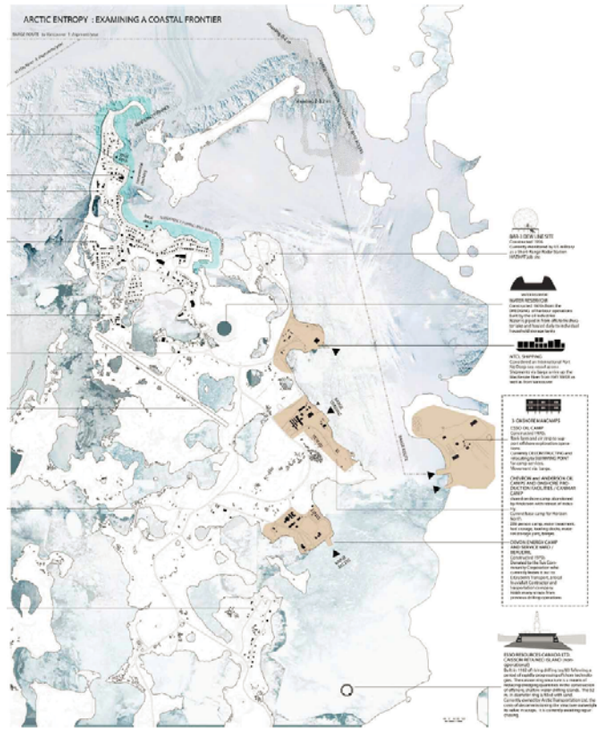
Tuktoyatuk: Responsive strategies for a new arctic urbanism

Pamela Ritchot, MIT 2011

For her thesis, Ritchot performs an incredibly thorough analysis of the history and context of the site, Tuktoyaktuk, which is located in the arctic along Canada's northern coast. The sheer quantity of drawings is striking, with the final thesis document reaching over 200 pages in length. She addresses a wide range of topics from the history of the region's indigenous Inuit population to the contemporary political tone and positioning of Tuktoyaktuk within the global economy as it is impacted by the changing arctic climate. While the majority of the drawings are clear and informative, a large number of them are ancillary and potentially unnecessary. The work product is a little unfiltered, which detracts from its clarity.

Though the thesis is from the department of architecture, it is relevant in the discipline of landscape architecture due to the integral roles of landscape, climate, and seasonal fluctuations. Her representation of sea level rise as a result of climate change is very effective. Ritchot makes effective use of rendered digital terrain models to simulate sea level rise and also integrates contour studies, which make her analysis more rigorous and precise. However, the vulnerability of Tuktoyaktuk to flood is, for the most part, the only major effect of climate change that Ritchot addresses. This is problematic given the host of other challenges that an arctic coastal community will encounter. For my topic in particular, the effect of climate change on snow (quantity, quality and duration), migration patterns, vegetation, and regional investment will be key topics to study.

Pamela Ritchot



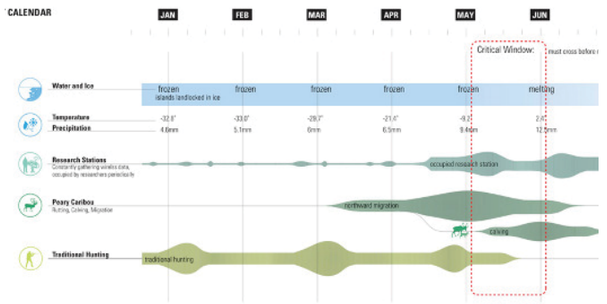
Pamela Ritchot

Caribou Pivot Stations

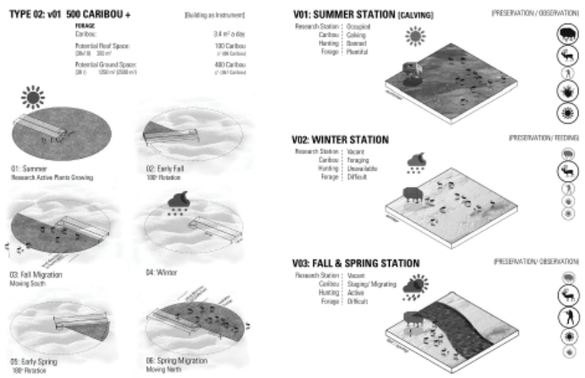
Lateral Office, 2010

Caribou Pivot Stations by Lateral Office attempts to address the challenge of increasingly difficult forage faced by Canadian caribou as a result of changing snow pack conditions. The proposed solution closely aligns the growing presence of northern research stations in Canada with caribou migration and nutritional needs. Lateral Office proposes a new research station typology with stations located along key points of the migration route with components that shelter the animals from the wind and other adverse conditions as well as mechanisms that clear snow and ice, exposing lichens for consumption. Caribou is the common name in North America for reindeer. Though they are wild, the animals studied in this project have very similar migratory practices as those in Norway, making it an especially relevant precedent. This project is particularly useful for its treatment of the temporal aspects of migration. The relationship between the caribou, seasonal weather patterns and the animals' eating habits is represented diagrammatically in calendar, simplified 3D section and in plan formats. Overlapping interests are also incorporated into this analysis with hunting season, and research center occupancy all playing major roles.

This project is very smart about aligning two existing interests in the Canadian arctic, that of the reindeer and that of the researcher. However, the proposed solution of a building with rotating gantries and wind walls considers only constructed features that would require considerable investment and maintenance. The potential benefit of existing landscape features and environmental criteria for site selection are not included, which is a lost opportunity.



Lateral Office

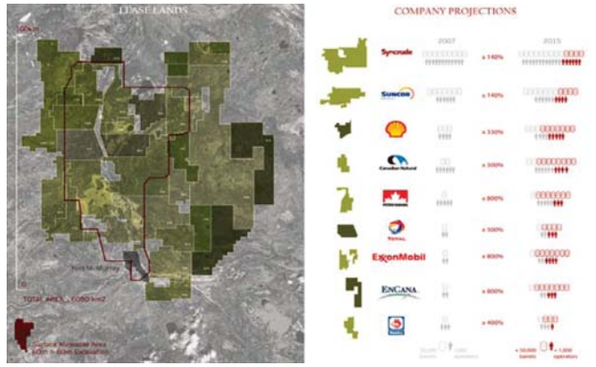


Lateral Office

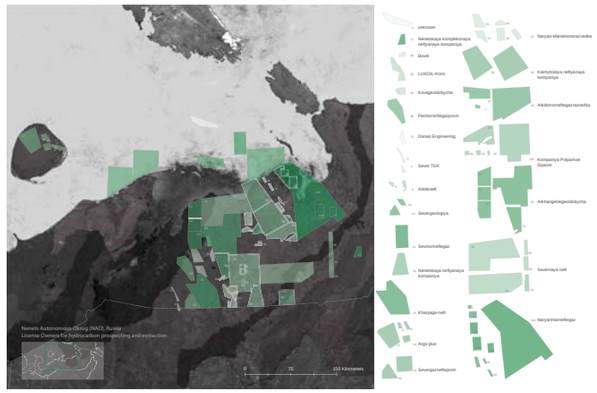
Operational Alternatives: (Re-) Configuring the landscape of Alberta's Athabasca Oil Sands

Kelly Doran

In this thesis project, Kelly Doran rethinks current resource extraction practices in northern Canada's Athabasca Oil Sands. He looks at the footprints of various international companies in the region and the nature of extractive practices to ultimately formulate a strategy for the productive reuse of decommissioned zones. He begins by indexing the lease holdings of companies active in the region and does further analysis into their growth potential, which is useful to gain an understanding of the profitability of the industry and the potential duration of industrial activity in the distant future. He then focuses on a particular company, Suncor, and tracks the extent of its activity at key points in the extraction timeline. He looks at the areas affected as Suncor expands its industrial activities, makes projections for areas affected at its peak of operation and then provides a proposal for post-peak use after Suncor has exhausted the resource potential of the site. The majority of this analysis is illustrated diagrammatically through the annotation of satellite imagery and aerial photography. This methodology is very effective at distilling a fairly complex subject matter that operates over a long time scale, into something easily understandable for the typical lay person. However, the oil sands region is treated within the project as an insular unit and we are given very little sense of its social context. It would be great to include diagrams of human settlement and infrastructure in the region so that we could begin to see the connection of extractive industry to local networks.



Athabasca mining leases
Kelly Doran



NAO, Russia oil drilling leases
Tracie Curry

Hypar-nature

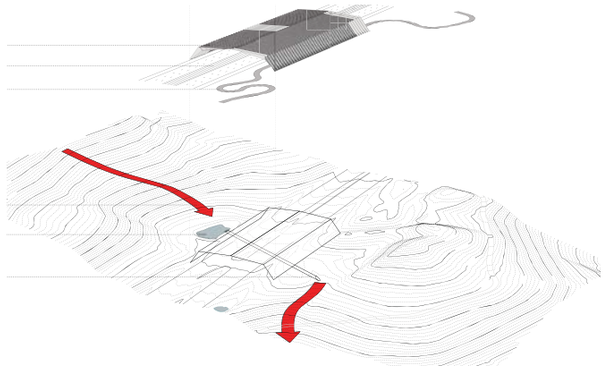
HNTB + MVVA Team

This joint effort between HNTB Engineering and Michael Van Valkenburgh Associates Inc. won the ARC International Wildlife Crossing competition in 2011. It stood out among other projects because of its innovative use of traditional building materials making it a cost effective design solution that addresses habitat fragmentation and reconciles animal/human mobility. It is both site specific and easily replicable, combining ecological principles with simple and affordable engineering components like pre-cast, modular concrete members. The wildlife crossing is only one component of a larger, regional scale network of wildlife overpasses.

Hypar-nature is a relevant precedent for this thesis as it shares many of the same motivations, most notably a need to maintain wildlife connectivity despite an increasing development footprint. I especially appreciate the proposal for its realistic approach and practicality. A common problem with many existing overpasses is that they are left unused by the animal populations they intend to help. However, the proposed project is more likely to achieve success as it takes into account existing wildlife corridors and incorporates forest, shrub and meadow plantings that mimic the conditions targeted species seek in their normal movements. Also, while the plantings are highly specific, the overpass structure is not. It utilizes cheap and readily available materials that most contractors are already familiar with. This combination of high effectiveness and low cost is always attractive to both public and private funding sources, making the proposal all the more feasible.

While the HNTB+MVVA wildlife overpass is a good solution for the particular context of the design competition, it would not be sufficiently comprehensive to address the challenges facing nomadic herders in the arctic. Though highway development is a significant cause of habitat fragmentation in this region, numerous other threats, including mining and climate change, also pose substantial challenges. While duplicability is still a major consideration here, the diversity of challenges facing herders necessitates greater variability. This might call for the use of site specific building materials in addition to those that are standardized and might require a number of different solutions ranging from the permanent to temporary or from the natural to the engineered.

HNTB + MVVA



HNTB + MVVA

Methodology

The research strategy undertaken for this thesis stems from the desire to produce a useful and thought-provoking contribution to ongoing debates over the conflicting land use interests of indigenous peoples and developers in the far north. This requires a high level of accuracy and clarity in the research and representation of the project. The issues of the region are driven by political, economic, ecological and cultural concerns, which are traditionally addressed independently and in piecemeal fashion by policy makers and engineers. While there are many ways one could approach the project from within the field of landscape architecture, the strategy chosen for this thesis is a holistic one, drawing from each of the abovementioned categories to create design that is not only functional but also interesting and culturally relevant. Cristophe Girot, in the essay Four Trace Concepts of Landscape Architecture, outlines a strategy of approaching landscape design in a way that "invokes cultural and imaginative horizons" rather than limiting it to strictly environmental concerns. To this end, he identifies four "trace concepts", landing, grounding, finding and founding, which follow a gradient of discovery, inquiry and resolution.

Landing

Landing occurs when one visits the site for the first time. It is the first act of site acknowledgement where one should feel before thinking. It is also the moment when the designer reacts to the differences between his/her preconceived notions of a place and its reality (Girot 1999). My site visit was conducted over a period of one week in July 2012. My initial site observations were recorded primarily by means of photography and annotation.

Right: Secondary description

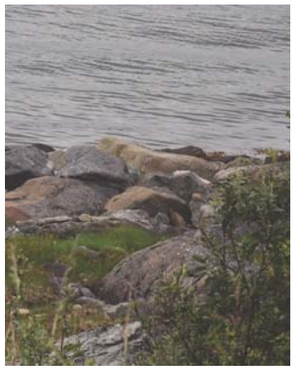
Grounding
While landing happens only once, the process of grounding is ongoing. Grounding is about reading and understanding the site through repeated visits and studies (Girot 1999). After my initial “landing” in Repparfjord and Kvaløya, I made repeated visits to both places for the duration of the site visit. It was especially valuable to make these visits in the company of varying stakeholders, which allowed me to obtain a diversity of perspectives on the same site. Indigenous knowledge and local studies, which could not have been obtained remotely, provided valuable information on the local impact of development and specific instances of conflict between opposing interests. Deming and Swaffield define this particular form of research as “secondary description”, or the summarization of observations or information that has been recorded by people other than the investigator (Deming and Swaffield 2011). Secondary description sources, particularly existing research and case studies, provided the majority of information for this project related to the history and practice of reindeer husbandry, arctic development, climate change and theories of common property.
In addition to collecting technical details during the first and subsequent site visits, I also made note of particular physical features to gain a sense of what unique elements define the character of the site. Steen Høyer, professor and director of the landscape architecture program at the Royal Danish Academy of Fine Arts in Copenhagen, refers to this as the “specificity of site”. It can be defined as the local conditions of material, light, space and structure that inspire us. Such local phenomena provide clues for how designers might create new landscapes on the basis of what exists in a given location (Hoyer 1999).
Post site visit, grounding continues with descriptive research, the recording of features and characteristics of a site or landscape as we find it (Deming and Swaffield 2011). For this thesis, the descriptive research design encompasses measurements of map data, diagramming, sectional analysis and the creation of an experiential journey along a migration route.

Mapping is a key research method due to the range of scales relevant to the project site. Reindeer migration routes operate within the confines of a district, regulatory issues begin at the state scale, and both economic and climatic issues span the whole of the arctic zone. In this phase of research, map data will be used to explore development growth, topography and the extents of climate change and its effects on vegetal zones. Particular topographic map features of interest will be translated into physical models for additional study.
Diagramming will be utilized to inventory the environmental, economic and political factors influencing the site. This method will be applied to reveal the often complex relationships and hierarchies underpinning site processes. Annual seasons, migration, regulatory systems and stakeholder groups will be inventoried using this method.
Sectional analysis will be integral in describing landscape relationships of the site. For example, topography plays a major role in reindeer migratory patterns as the animals prefer to be at higher elevations during warmer months. Additionally the relationship between surface and subsurface rights will be important to consider in relation to proposed mining activities in the region.
Finally, a descriptive sequential journey along the migration route will likely prove extremely helpful to clarify the practice of migration, both for myself and especially for those that are not familiar with it. The success of the migration and a number of other events that occur along the length of the route rely on a combination of environmental factors, like forage, snow pack and ice at particular points in particular seasons. A virtual landscape simulation or animation would be ideal for the representation of these complex relationships.

Finding
Finding is the act and process of searching as well as the outcome (Girot 1999). While the research methods conducted during the grounding phase were primarily a means of cataloguing and understanding existing site conditions, in the finding phase this information is taken a step further through comparison, interpretation and exploration. Mapping exercises will focus on the layering of information from different sources to identify overlapping conditions and potential opportunities. Furthermore, relationships represented in section will move beyond being purely informational to become experimental as a means of testing new scenarios and arrangements. Both digital and physical study models will be constructed to assist in this process.

Founding
Founding is the combination of the prior three acts, synthesized into a new and transformed construction of the site (Girot 1999). Here, the processes of testing and exploration that began in the finding phase are developed further to produce targeted interventions in an integrated site context. The external factors affecting the site, including climate variability and global market fluctuations, ensure that nothing will remain constant. Therefore, it is necessary that proposed solutions incorporate a level of flexibility, including functionality across a wide range of conditions and even a plan for failure. To this end, scenarios will be developed for normal, best, and worst cases with immediate, near and long term horizons. These scenarios will be tested and developed through the use of digital modeling and parametric software.
Throughout the evolution of the project, proposed strategies will undergo multiple instances of peer and faculty evaluation. The project and its methodology will be continually refined from beginning to end and, like the site processes themselves, are likely to change.





Annotated Bibliography

Design Sources

Design Sources

Collymore, Peter. The Architecture of Ralph Erskine. London: Academy Group Ltd., 1994.

Corner, James, Maclean Alex. “Taking Measures Across the American Landscape”. New Haven: Yale University Press, 1996

Notable for the combination of aerial photography and diagramming techniques. Play on the interrelationship of numerical, instrumental and ethical dimensions of measurement. Currently thinking that this approach could be useful for me as I intend to utilize ortho images to call out particular points along the long site section I am working on. Questions of accuracy, and appropriateness are very relevant.

Deming, M. Elen, and Simon Swaffield. Landscape Architecture Research. Hoboken: John Wiley & Sons, Inc., 2011.

Erskine, Ralph. “Building in the Arctic.” Architectural Design, May 1960: 194-198.

Erskine, Ralph. “Indigenous Architecture: Architecture in the Subarctic Region.” Perspecta 8, 1963: 59-62.

—. “The Sub-Arctic habitat.” CIAM ‘59 in Otterlo. New York: Universe Books Inc., 1959. 160-169.

Girji, Davvi. The Sami- An Arctic Indigenous People. 2008.

Girot, Christophe. “Four Trace Concepts in Landscape Architecture.” In Recovering Landscape: Essays in Contemporary Landscape Architecture, by James Corner, 59-66. New York: Princeton Architectural Press, 1999.

Approaching landscape design in a way that “invokes cultural and imaginative horizons” rather than limiting it to strictly environmental concerns.

Girot identifies four “trace concepts” in landscape architecture which, when undertaken in order, follow the gradient of discovery, inquiry, and resolution.

Landing: The first act of site acknowledgement. Requires a certain state of mind where one feels before one thinks. Refers to the moment when a designer reacts to the difference between his/her preconceived idea of a place and the reality that appears during the first steps of a visit.

Grounding: Landing happens once while grounding happens indefinitely. More about reading and understanding a site through repeated visits and studies.

Finding: The act and process of searching as well as the outcome. There are many methods of finding because different activities yield different discoveries. Finding usually discloses the evidence to support ones intuitions about a place.

Founding: Comes at the moment when the prior three acts are synthesized into a new and transformed construction of the site. A well-founded project remains clear in its approach and resolution, extending the legacy of a place toward a productive future

Hoyer, Steen A.B. “Things Take Time and Time Takes Things.” In Recovering Landscapes: Essays in Contemporary Landscape Architecture, by James Corner, 68-77. New York: Princeton Architectural Press, 1999.

This essay makes a case for the transformation of the traditional Denmark landscape in contrast to common preservation practices, which seek to keep landscape as a “static framed picture”. These modes of experiencing the land reduce it to something solely visual. This “misses a great opportunity to reshape the land as a democratic reflection of modern society and emerging conditions”. Principles under which a new landscape formation in Denmark may be practiced:

- Specificity of Site: Local conditions of material, light, space and structure ought to inspire and generate new forms of design as needs and desires change. Local phenomena such as light, weather, topography, horizon and earth provide clues for how we might create new landscapes on the basis of what exists in a given location
- Space as Strategy: Primacy accorded to space as a strategic organization of new conditions, not as a stylistic genre. Architectural experiences should be taken at their face value as experiences and not as historical or textual references.
- Surface as Strategy: Surface as bearer of elements and the key strategic field on which landscapes may be organized and designed. Vegetation and building material, sky and earth, support one another and combine into a single, interactive entity.
- Things Take Time: Designers must always anticipate varying degrees of slowness in both the practice and reception of their work.

Swaffield, Simon, and Jorgen Primdahl. “Spatial concepts in landscape analysis and policy: some implications of globalisation.” Landscape Ecology, 2006: 315-331.

‘Place-based’ spatial concepts, which dominated 20th century landscape planning and design, are no longer sufficient. It is now also necessary to understand how the ‘global space of flow’ is shaping landscape change and how local landscapes are responding to and resisting their influence.

Recognition that pattern and process in contemporary cultural landscapes is not only scale dependent in ecological terms, but is also dependent upon different scales and dimensions of social process.

A new type of planning strategy is needed to bridge between local place and global space. However, must shift from the earlier focus upon ‘bounded’ space as a primary way of ordering the regional landscape to a greater emphasis on layered and networked spatial frameworks.

Long term resilience dependent upon their alignment with either essential ecosystem elements or with iconic cultural systems

Regional planning agencies have appeared poorly prepared to respond to recent waves of change. Failure is fundamentally related to a reluctance to fully utilize the power of hierarchical spatial understanding, representation and imagination.

Key Words:
Bounded space: expressed as territory, landschaft, country, district, field and precinct. Fundamental to the definition and allocation of property rights to utilize resources, occupy land and determine land use.
Networked Space: analyzed in terms of linear patterns, corridors and connections between nodal points. For example, greenways in which biophysical or cultural linear features provide an ordering logic to connect different locations.
Layered space: third type of order, which analyzes space in terms of discrete categories of information, function, features and narratives. A way to deconstruct the multiple social and historical narratives that are embodied within landscape.

Manuel Castellas (social theorist): The spatial separation between power and resources is not new. However, the new global economy exerts control over distant parts of the world on both spatial and temporal terms.

Good fit between the space of places and the concepts of bounded landscapes and landscape networks. Forman (1995) cites Steinitz in noting the similarity between the landscape and ecological concepts of patch, corridor, and edge, and the spatial planning language developed by Lynch (1960)

Hierarchy theory (Allen and Starr 1982): Developed to address complexity in ecological systems. There is a hierarchy of function and causality within complex systems, in which higher order levels act as constraints upon lower levels. Most landscape ecological applications are nested hierarchies in which lower level, smaller scale components are contained within higher level, larger scale components.

Reindeer Husbandry

Dallmann, Winfried, Vladislav Peskov, and Olga Murashko. Monitoring of Development of Traditional Indigenous Land Use Areas in the Nenets Autonomous Okrug, Northwest, Russia. Research, Norwegian Polar Institute and Assoc. of Nenets People Yasavey, 2010.

Anna sent me this report and I have found it super useful. There is a great GIS database connected with this project. I'm not sure yet how I will incorporate this into the thesis research as it focuses on the NAO area of Russia. Might be great to present as an alternate case for comparison?

Eira, Ravdna Biret Marja. Using Traditional Knowledge in Unpredictable Critical Events in Reindeer Husbandry. Thesis submitted for the degree: Master of Philosophy in Indigenous Studies, Faculty of Humanities, Social Sciences and Education, Tromso: University of Tromso, 2012.

Jernsletten, Johnny-Leo, and Konstantin Klokov. Sustainable Reindeer Husbandry. Tromso: Centre for Saami Studies, Tromso University, 2002.

This is a good source for specific information about reindeer husbandry. There is a separate section for the primary husbandry areas (Russia, Alaska, Norway, Sweden and Finland). The eight seasons of reindeer husbandry are detailed on pages 18 and 19. The divisions reflect what is important to the reindeer in each season. Key is the "diversity of seasonal pastures with sufficient carrying capacity".
Spring (April-May): Calving season. The reindeer will be in the calving land with small hills and protection against cold wind. Will have patches of snowless ground, often in a southern slope where the sun is warming. Calves and their mothers should not be separated
Spring-summer / early summer (June): Intensive grazing activity. Important that they can graze undisturbed in one area. Good pastures allow the opportunity for them to grow and become stronger
Summer (June-July): Animals are moving towards higher grazing areas, or further out on the coast. In the mountain, patches of snow allow the reindeer to get cooled down and escape from the bugs, and eat new grass as the snow melts. On the coast, fresh winds from the sea drive the bugs away. This is also the time for the owner to ear mark.
Autumn-summer (August): The animals are still grazing on green pastures but mushrooms are also an important part of their diet. They are now building fat reserves for the winter.
Autumn (September-October): Cold nights make the green pastures wither and the animals gradually change their diet to lichen. This is also the rutting season where some of the bulls are slaughtered before they go into heat, which will give the meat a non-pleasant taste.
Autumn-Winter (November-December): Lichen pastures get more and more important for the animals. This is also the slaughtering season. Important work for the owner to decide the herd structure. Which animals should be slaughtered and which should be used for breeding. After slaughtering, animals are collected into different herds and the move down to the winter pasture begins.

Maynard, Nancy, Anders Oskal, and et al. “Impacts of Arctic Climate and Land User Changes on Reindeer Pastoralism: Indigenous Knowledge and Remote Sensing.” In Eurasian Arctic Land Cover and Land Use in a Changing Climate, by G. Gutman and A. Reissel. Springer Science+Business Media B.V.2010, 2010.

Magga, Ole henrik, and Svein D. Mathiesen. “Reindeer Herders’ Vulnerability Network Study: Reindeer Pastoralism in a Changing Climate.” IPY EALAT Research - Final Report to Research Council of Norway Project Number 176078, 2011.

Nellman, C., I Vistnes, H Ahlenius, and et al. Snohvit and Saami reindeer husbandry outlook, impacts and mitigation. Impact assessment, Trondheim: NINA Norwegian Institute for Nature Research, 2002.

Nellman, Christian, and Ingunn Ims Vistnes. Proposed development of mines - consequences for reindeer herding in Fiettar and Fala. Impact Assessment, Alta: Northern Research Institute, 2011.

Oskal, A., Turi J. M., Mathiesen S. D., Eira I. M. G., Yurchak B., Etylin V., Gebelein J. 2010 - Impacts of Arctic Climate and Land Use Changes onReindeer Pastoralism: Indigenous Knowledge & Remote Sensing. Chapter 8. In: Eurasian ArcticLand Cover and Land Use in a Changing Climate. (Gutman, G., Ed.) Springer. pp. 177- 205.

Sara M. N. 2009 - Siida and Traditional Sámi Reindeer Herding Knowledge. The Northern Review 30: 153-178.

Tyler, N.J.C, J.M Turi, and et al. Saami reindeer pastoralism under climate change: Applying a generalized framework for vulnerability studies to a sub-arctic social-econogical system. ScienceDirect, Global Environmental Change, 2007.

Vistnes I, Burgess, P., Mathiesen, S.D., Nellemann, C., Oskal, A. and Turi, J.M. 2009: “Reindeer Husbandry and Barents 2030. Impacts of Future Petroleum Development on Reindeer Husbandry in the Barents Region.” Report for Statoil Hydro Barents 2030 Scenario Programme. International Centre for Reindeer Husbandry Report 1:2009

Vitebsky, Piers. The Reindeer People, Living with Animals and Spirits in Siberia. Boston: Houghton Mifflin, 2006.

This book is an anthropological study of the Evenki people who are reindeer herders in Siberia. I thought it might be useful to skim this to maybe draw some parallels between Russia and Norway. While there are very many similarities regarding the management of the herd itself, there are significant differences. The primary differences have to do with the way reindeer husbandry is regulated in Norway as compared to the way it was historically regulated in Russia.

Climate Change and the Arctic

Arctic Portal. Arctic Portal. 2012. http://portal.inter-map.com/#mapID=49&groupID=293&z=1.0&up=568.7&left=2001105.4 (accessed November 08, 2012).

Brigham, Lawson, Vladimir Grischenko, and Kazuhiko Kamesaki. “The Natural Environment, Ice Navigation and Ship Technology.” In The Natural and Societal Challenges of the Northern Sea Route, by Willy ed. Ostreng, 90-120. Dordrecht: Kluwer Academic Publishers, 1999.

Huntington, Henry, Shari Fox, and et al. Arctic Climate Impact Assessment, Ch3 The Changing Arctic: Indigenous Perspectives. Research, Cambridge: Cambridge University Press, 2004.

Instances, Arne. Infrastructure: Buildings, Support Systems and Industrial Facilities. Arctic Climate Impact Assessment, Cambridge: Cambridge University Press, 2004.

National Research Council. Environmental Information for Outer Contintntal Shelf Oil and Gas Decisions in Alaska. Study, Washington D.C.: National Academy Press, 1994.

I checked out this book for my studio project which is sited in Alaska. However, there were a couple of points regarding native Alaskans that I thought were applicable to this thesis.
Long Term Cumulative Change:
“Local people begin to adapt to changes, but when the changes (extraction of oil, for example) stop, the population cannot return to its earlier condition even if the adaptations are no longer needed or functional” pg 132
“One ironic result of what often happens when dependence on extraction (dependence on revenue from oil and gas development and production) is coupled with remoteness is that there can be a long-term increase, rather than decrease in local poverty” pg 133
Extreme Isolation:
Even more so than for the more southernly regions of Alaska, the North Slope has a high degree of dependence on economic input from the lower 48 states, exacerbated by the high cost of transporting even basic goods, such as fruit and vegetables, to a region that has little capacity to grow its own. The region also has an extremely high dependence on extractive industries and hence especially high levels of susceptibility to potential boom-and-bust disruptions” pg 137.
- The above parallels the situation (remoteness) in Russia more than in Norway

Ostreng, Willy, ed. The Natural and Societal Challenges of the Northern Sea Route. Dordrecht: Kluwer Academic Publishers, 1999.

Pressman, Norman. Northern Cityscape. Yellowknife: Winter Cities Association, 1995.

Vaughan, Richard. The Arctic: A History. Gloucestershire: Sutton Publishing, 2007.

Natural Resource Management

Ciriacy-Wantrup, S.V., and Richard Bishop. ""Common Property" as a Concept in Natural Resources Policy." Natural Resources Journal, 1975: 713-728.

This article suggests looking to the history of Common Property for insight on current natural resource policy issues like fisheries.
Usual proposed solutions run in two directions.
1. Make the "common property" resource in question the private property of individual resource users, who, via the "invisible hand" will manage the resource in society's best interest
2. Problem is to be solved by governmental intervention (taxes or subsidies) designed to bring private and social costs into balance.
Common Property: defined as a distribution of property rights in resources in which a number of owners are co-equal in their rights to use the resource. Their rights are not lost through non-use. Co-equal owners are NOT necessarily equal with respect to the quantities of the resource each uses a period in time. Common property is not everyone's property.
Grazing on the commons under European tradition
- Seasonal, the beginning and end of each grazing season were set uniformly
- Grazing permitted only during daylight hours
- Strong controls maintained only by the requirement that each individual livestock owner have sufficient feedbase to support livestock during non-grazing period
- In the case where over-grazing was a threat, common users were assigned quotas.

As the profitability of forestry increased, grazing and wood gathering became an impediment.
- The peasant was transformed from a co-equal owner on the commons (with secure tenure) to a landless worker on a feudal estate.

Communal hunting and gathering societies:
- Fission: as group size grows, groups tend to split and become established in new areas
- Rules of sharing prevent depletion of resources for individual gain
- The most important outside interference with these societies has been contact with the market economy and other aspects of western society (overuse of resources in order to obtain a marketable surplus)

Contemporary parallels:
- Fisheries- Restriction on input (fishing vessel tonnage) versus restriction on output (fish)
- Ground water rights

McKean, Margaret. "People and Forests." In People and Forests: Communities, Institutions and Governance, by Clark Gibson, Margaret McKean and Elinor Ostrom, 27-55. Cambridge: MIT Press, 2000.

Good overview on the difference between public goods, private goods and common-pool goods. An especially applicable section is Uncertainty in Location of Productive Zones (pg 38) which talks about how certain resources (like forests) cannot be parcelized as its functionality is dependent on the whole. What happens upslope has an effect on the downslope and if each of them is owned separately then the resource cannot be managed properly.

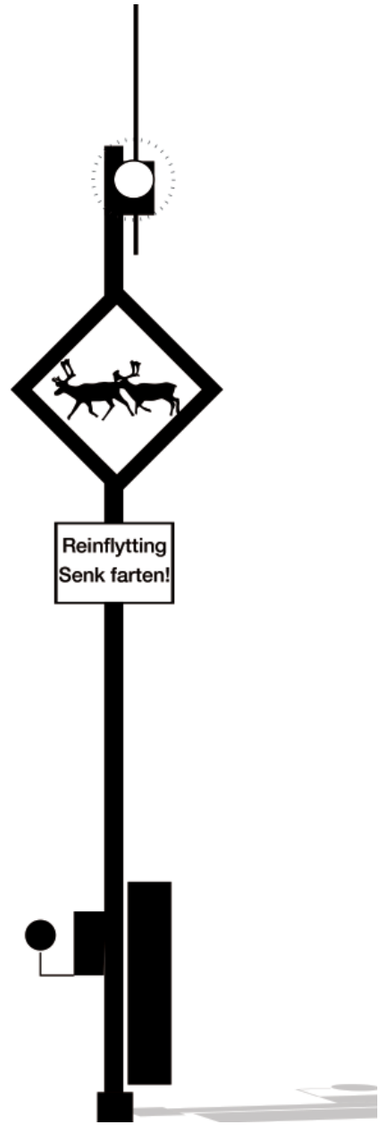
Sandberg, Audun. "Collective rights in a modernizing North." Inernational Journal of the Commons, 2008: 269-287.

Annex to the early Border Treaty between the Sweedish/Finish State and the Danish/Norwegian State regarding Sámi nomadic pasturing rights of the 'Lappecodicill', 1751. Indigenous groups do not lose their right to land and water by being subjected to a state's sovereignty
For the Sami, the institutionalization of heavy modernization did not start until 1852 when the borders between Norway, Sweden and Finland were closed to Sami reindeer migrations. This also became the start of a period of heavy Norwegianization of the Sami group.

Schlager, Edella, and Elinor Ostrom. "Property-Rights Regimes and Natural Resources: A Conceptual Analysis." Land Economics, 1992: 249-62.

Article about bundles of rights associated with four classes of property rights, owner, proprietor, claimant and authorized user. The associated rights are access/withdrawal, management, exclusion and alienation. Gives an overview of various levels of "ownership" that can exist with common pool resources and the incentives associated with each of them.

Design Document



Migration routes

B

A

Natural features

Conflict zones

Kvaløya - Increasing development

Kvalsund - proposed mine site

Winter pasture - vulnerability to climate change

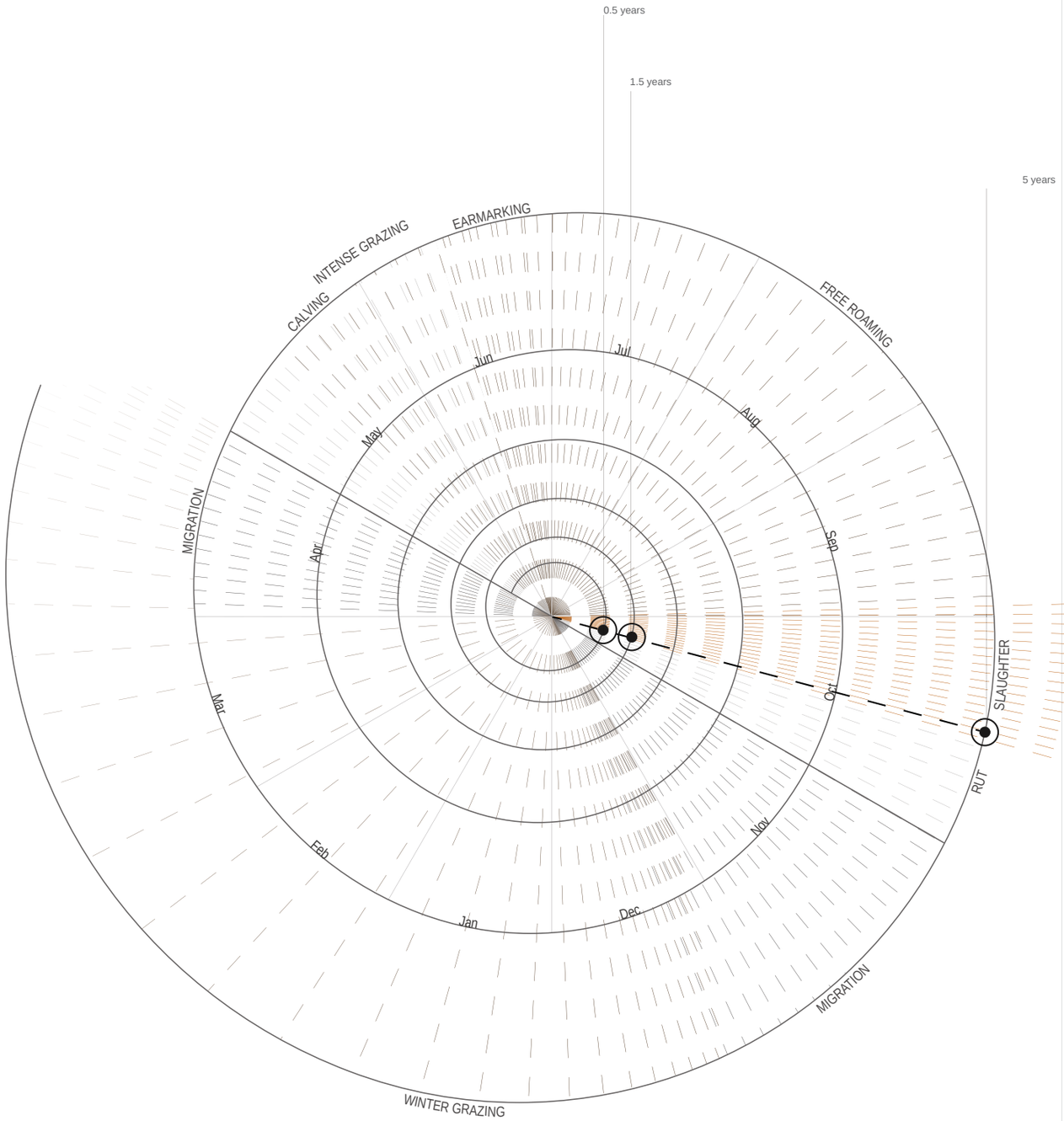
protected area

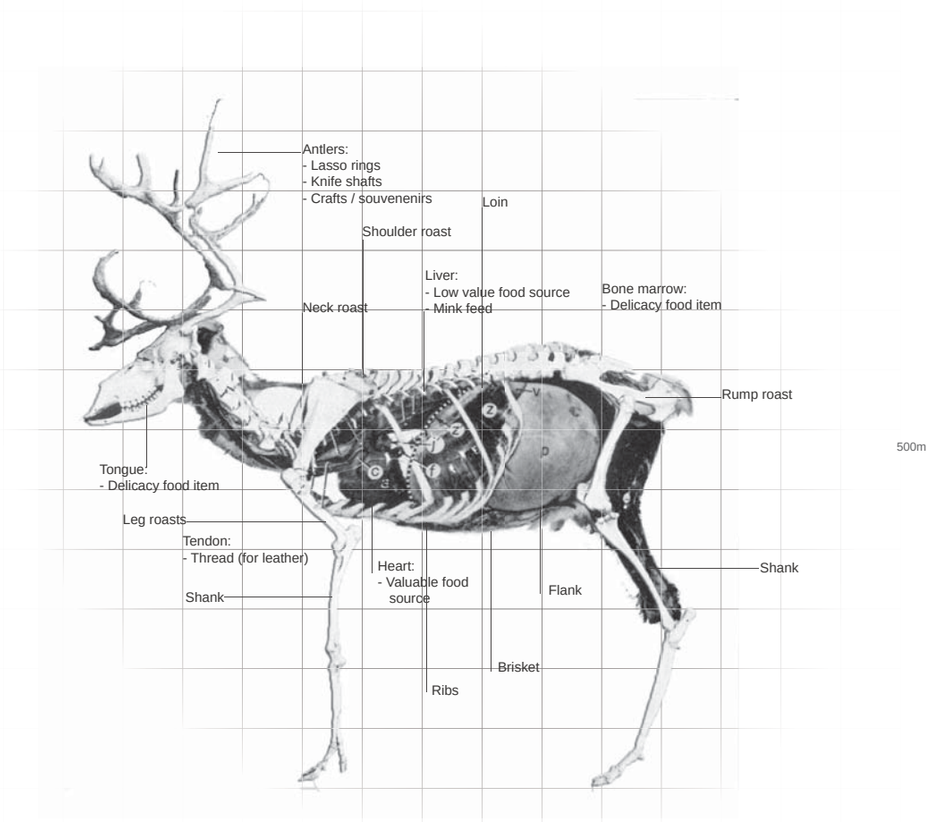
suggested protected area

A

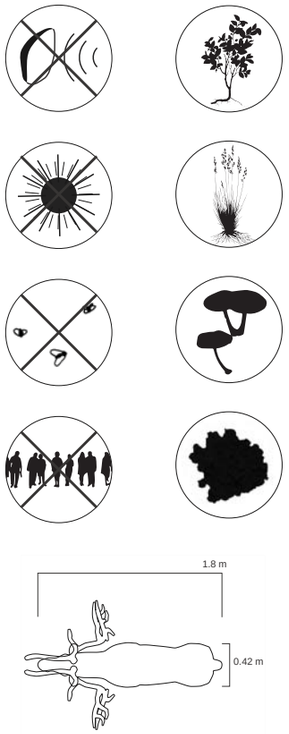
B

Lifecycle calendar



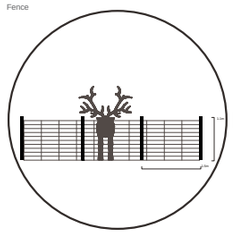


500m



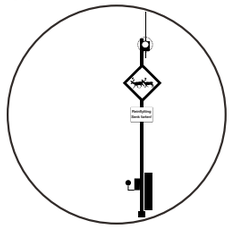
Strategies

Fence

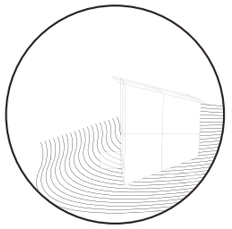


Pasture Improvement

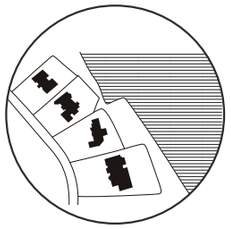
Signage



Hillside development



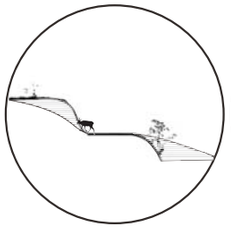
Buffer zone



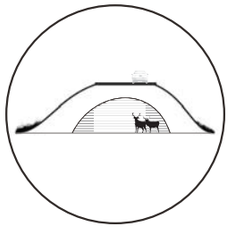
Overpass - flat grade

Overpass - valley

Cut/fill - steep slope



Underpass - hill



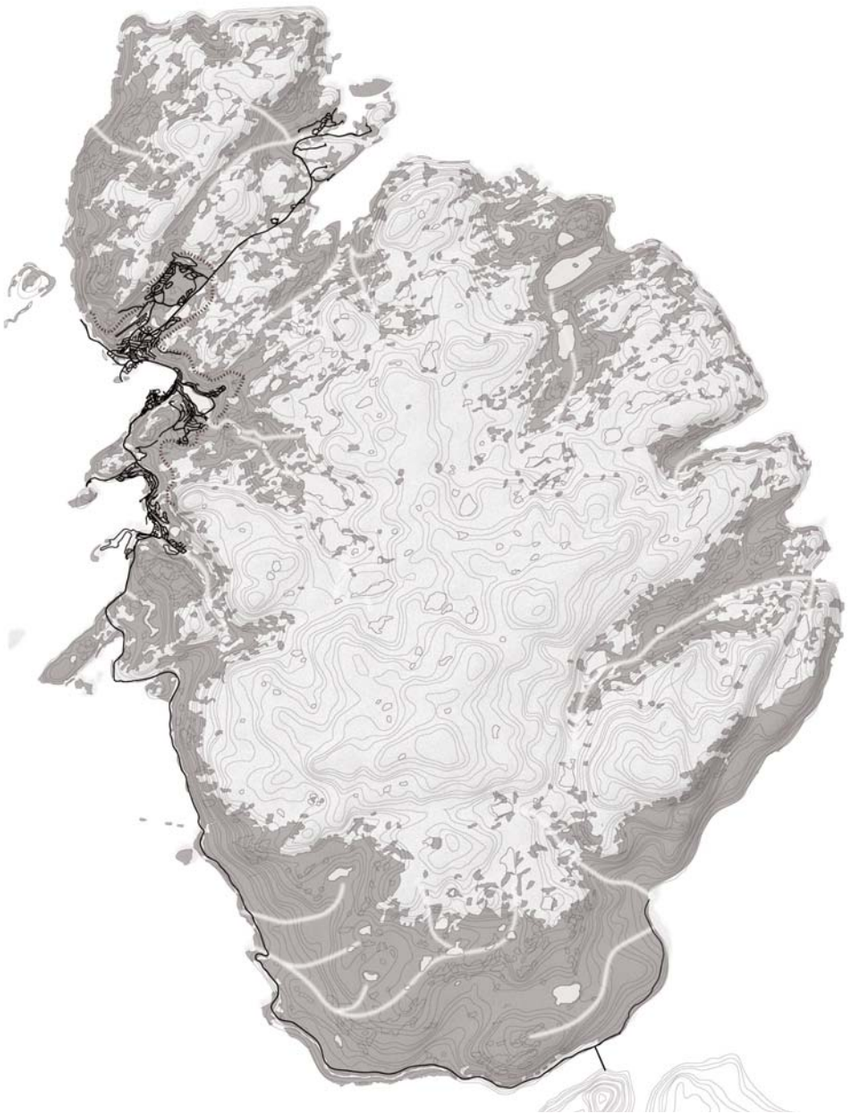
Kvaløya

Development pressure

Pasture amelioration

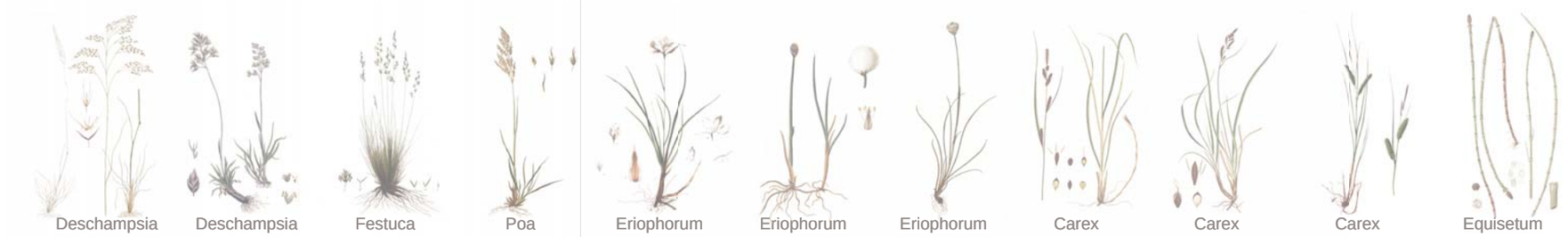
Maintian the quality of existing pastures and increase the productivity of sparsely vegetated areas.

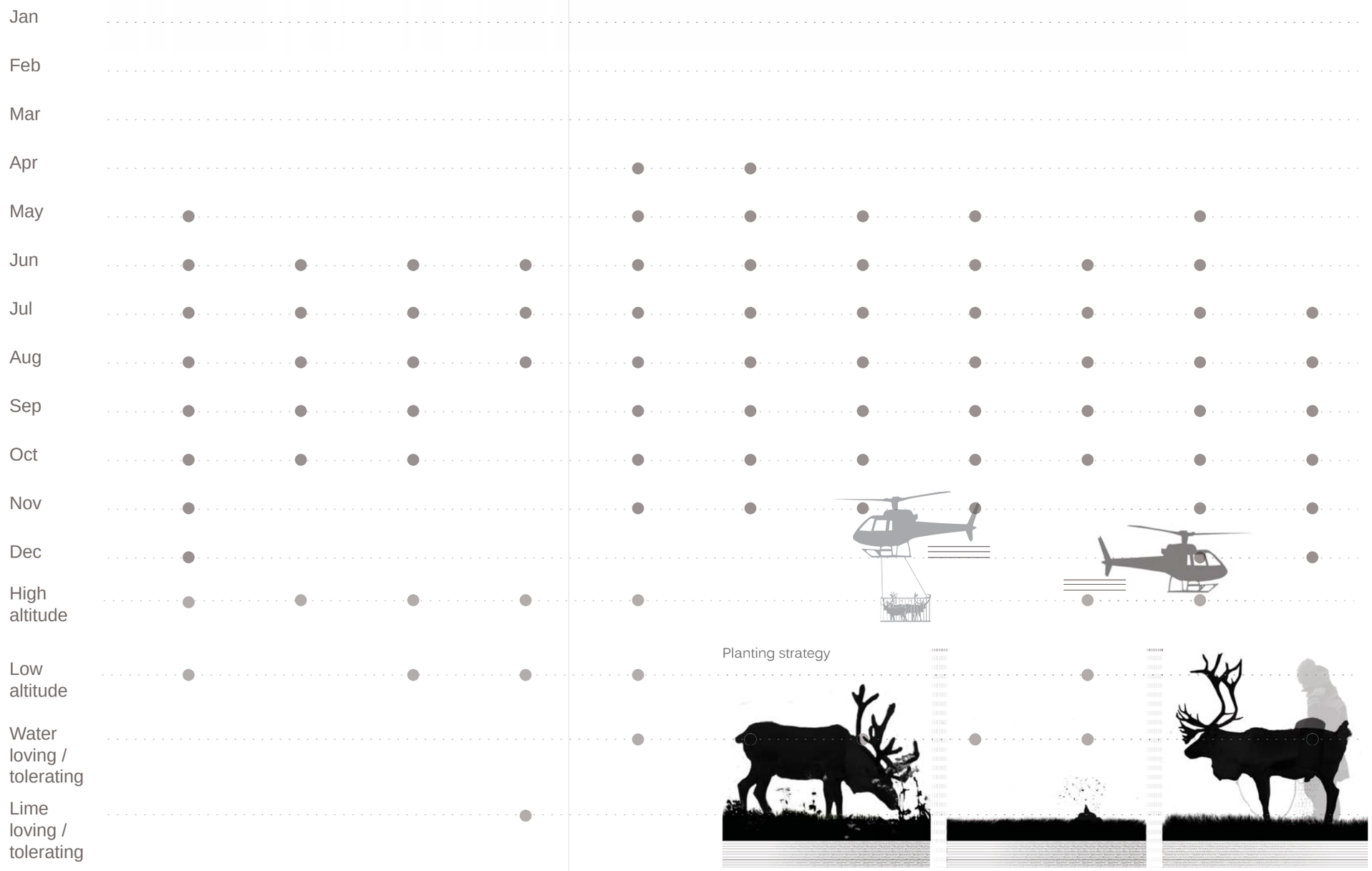
Upper right: Summer pasture movement
Lower right: Areas with dense vegetation



Oversowing:

Oversowing is a commonly used method of diversifying grassland. Reindeer naturally assist in site preparation by grazing and fertilizing in the spring and summer. Seeding should be done in the late summer or fall to accommodate autumn germinating species and those that require a period of cold to break their dormancy. Reindeer can also assist in the process by “broadcasting” and bedding the seed during their return journey south. Seed may be broadcast over larger areas through use of machinery or by commissioning helicopters for this purpose.

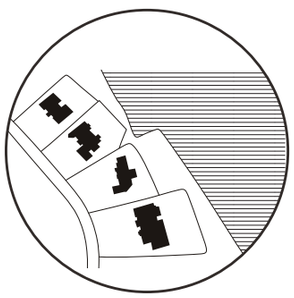




Planting strategy

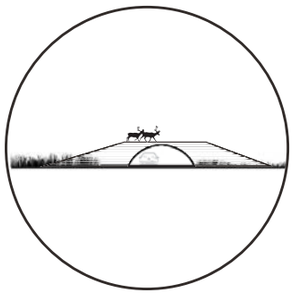
Development guidelines

Stream corridors provide quality grazing lands with dense and nutritious forage, particularly early in the season. As Hammerfest development progresses inland, it follows the slope of valley floors, often compromising these important areas. Development guidelines should restrict development within buffer zones to specified uses and densities.

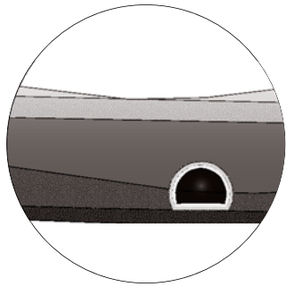


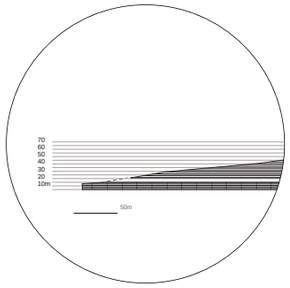
Tunnel

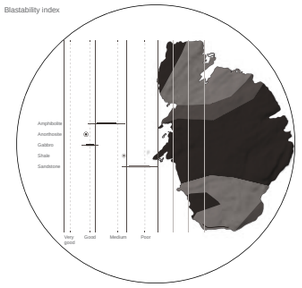
Norway is considered a leader in tunneling with over 900 road tunnels totaling over 750km in length. In Kvaløya, tunnels built for the benefit of road traffic have had the side effect of also benefiting reindeer and their herders by freeing passage across busy roadways. Where blasting conditions permit, tunnels are an effective means of addressing avalanche or wind hazard and improving traffic flow. Furthermore, the debris from tunneling can be for a number of favorable uses, particularly the creation of new land either to accommodate industrial access or to improve access routes to existing grazing sites.



Tunnel

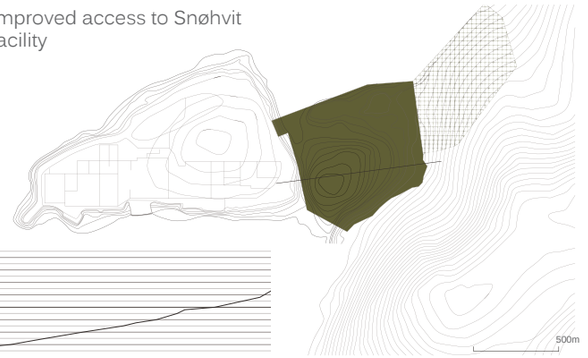




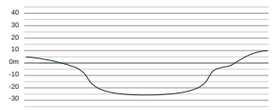


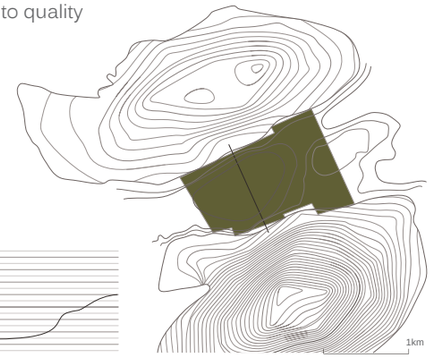
Debris = fill material

Improved access to Snøhvit facility



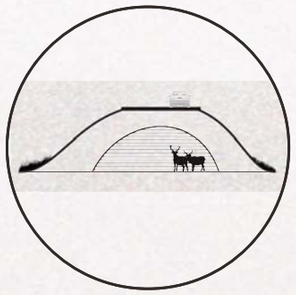
Improved access to quality pasture



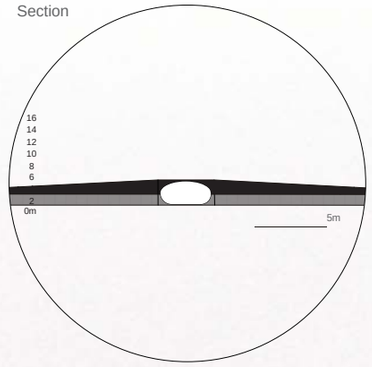


Underpass

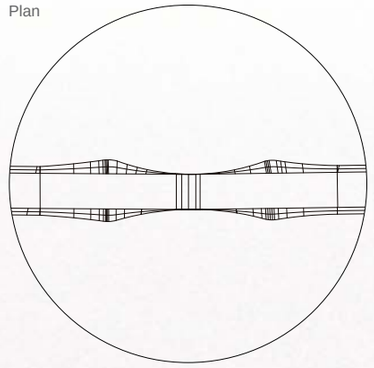
With new development planned in both Hammerfest and the town of Forsøl, greater traffic volumes are expected on Fv391, currently the only connecting road. To maintain access to grazing lands on the opposite side of the road, a system of highway underpasses is proposed. In addition to maintaining connectivity, the underpasses provide herders a means of regulating the flow of reindeer on either side, allowing for easier management of the pasture and herd.



Section



Plan



Kvalsund

Copper mine

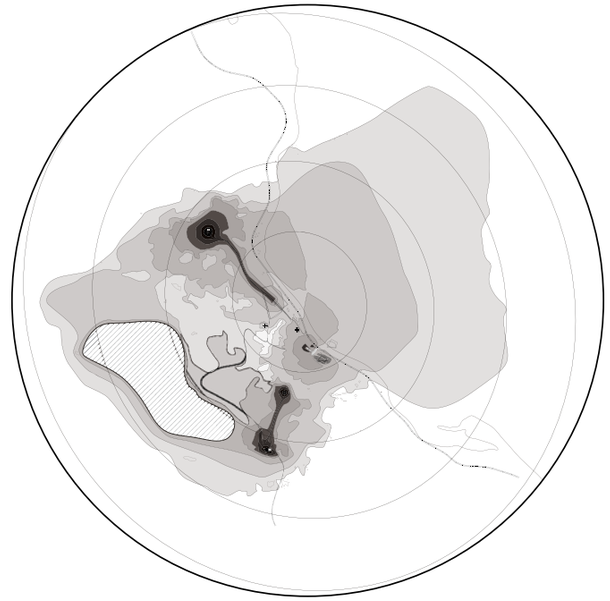
Repparfjord

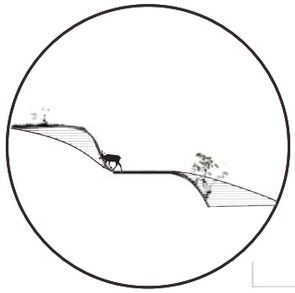
Mine outline

Proposed landfill

Gravel pit

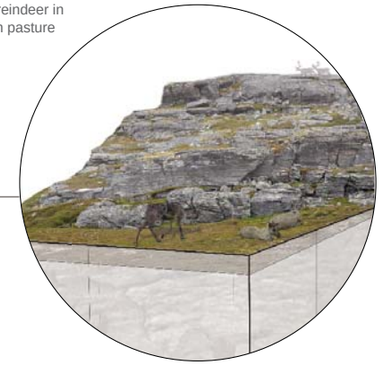
Mine Noise study



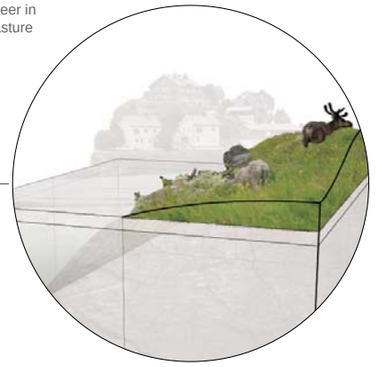


500m

Female reindeer in mountain pasture



Male reindeer in riparian pasture



Reindeer herds pass through Kvalsund during a critical period of the northward migration. At this time, females are pregnant and on their way to calving grounds. The proposed copper mine and landfill, threaten to obstruct passage through this area. To minimize impact, alternative methods of tailings disposal should be considered. Instead of one large landfill, non-toxic debris can be strategically distributed to create more traversable slopes throughout this hilly terrain.

Riparian

Tree line

Mountain

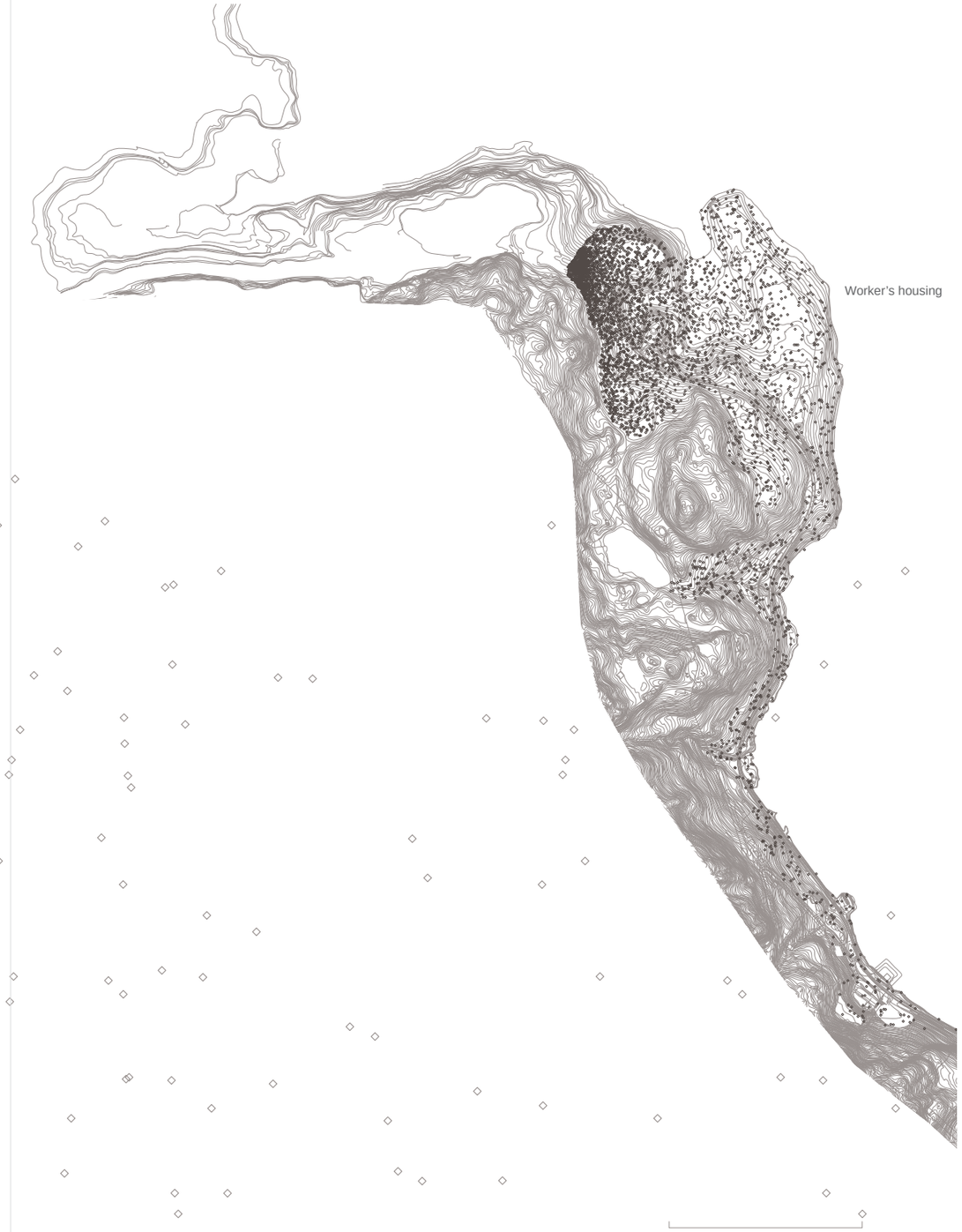
Powerline

Female reindeer

Male reinceer

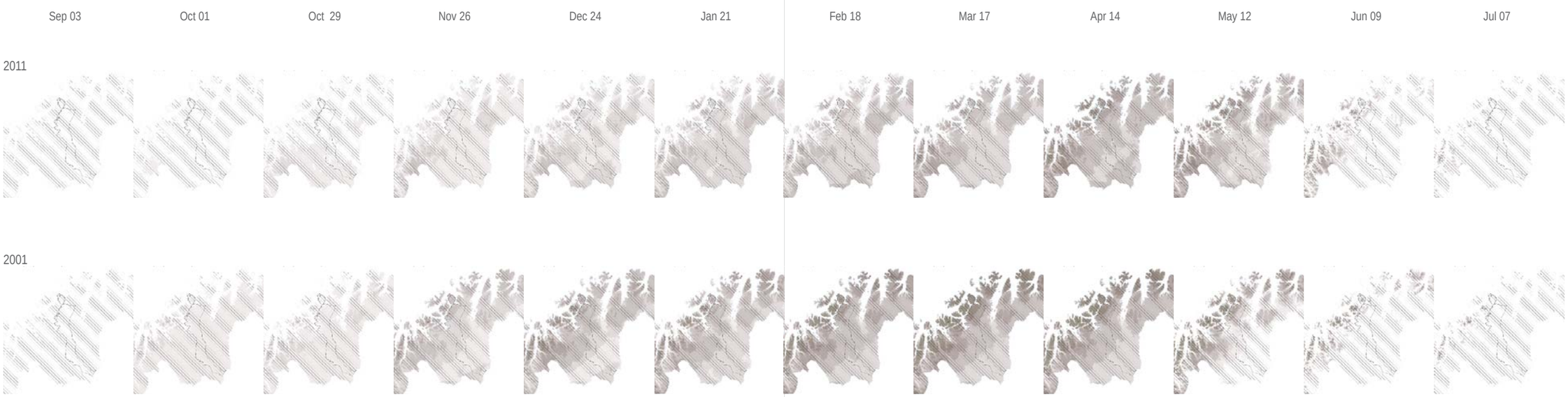
500m

The riparian areas are the first to grow green pasture during the spring snowmelt. It is important that access to these lands is maintained during the northward spring migration. Development, in the form of mining facilities and workers housing should be organized to allow for movement along the coast . This creates a pattern of development that becomes more permeable with proximity to these critical areas.



Winter Pasture

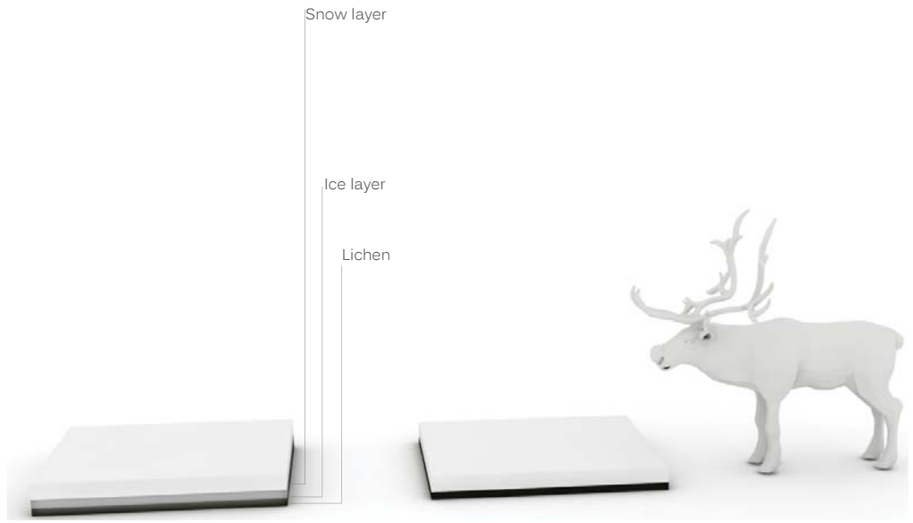
Climate vulnerability



The visible effects of climate change:

The above images show the decline in Finnmark snow coverage over a decade. Shorter spring seasons are one of a number of challenges faced by reindeer herders in the changing northern climate.

Increased variability in freeze-thaw cycles can lead to a condition where a thick layer of ice obstructs reindeer’s access to the lichen below. In extreme cases, this may lead to starvation.



"In a uniform landscape without alternatives, one is left helpless when faced with natural changes"

- Mikkel Nils Sara

The effects of climate change are causing increasingly variable weather events and atypical patterns of vegetal distribution. As reindeer pastures are gradually more compromised by these changes, the strangling inflexibility of the current regulated land use system becomes ever more apparent. The more landscape types reindeer pastoralism has access to, the more secure it will be over a longer period of time. Greater resilience can be achieved through increased flexibility and ability to exploit alternatives within the regional environment, suggesting the potential to achieve synergies through cross-border agreements and common use.

Appendix

Site Photography

Roads

Caution, reindeer crossing

Neverfjord, Norway

Reindeer on highway in
Repparfjord, Norway

Roads

Sheep resting along highway in Repparfjord, Norway

Mineral Resource Development

Gravel pit as seen from above, Repparfjord, Norway

Gravel pit
Repparfjord, Norway

Copper mine site
Repparfjord, Norway

Coppermine refuse
Repparfjord, Norway

Copper mine site
Repparfjord, Norway

Mineral Resource Development

Repparfjord, proposed location of mine tailings disposal

Hammerfest and Natural Gas Development

Bridge to Kvaløya Island and the city of Hammerfest

Hammerfest avalanch protection

Hammerfest port

Hammerfest and Natural Gas Development

Hammerfest port from above with Statoil flame in the distance

Statoil offshore LNG processing facility

Hammerfest and Natural Gas Development

Statoil offshore LNG
processing facility

Mayor of Hammerfest
Pro onshore development

Hammerfest and Natural Gas Development

Reindeer herders
Anti onshore development

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