Extensive review of the national boundary between Sweden and Norway

Dan NORIN, Sweden, Anders ØSTERAAS, Norway, Martin LIDBERG, Sweden, Tor Erik BAKKE, Norway, Mikael LILJE, Sweden

Key words: National boundaries, national boundary demarcation, national boundary review, boundary markers, RTK surveying

SUMMARY

The national boundary between Sweden and Norway is about 1634 kilometres long and it is the longest national boundary on land in Europe. The boundary is mentioned already in the 11th century and treaties from the 17th and 18th centuries are still the basis for today's modern definitions. It is marked by over 600 about 1.5 metres high stone cairns. Almost 300 of them were erected already during the 18th century and they are in that sense true cultural heritage. In addition, other boundary markers are also used, such as sign posts where roads and hiking trails cross the boundary. There is also a five-metre-wide clearing along the boundary.

Since the 18th century, reviews of the national boundary between Sweden and Norway have been carried out with an interval of about 25 years. For the most recent review conducted 2020–2024, the Swedish and Norwegian governments appointed boundary commissions in each country. The Swedish commission is situated at Lantmäteriet (the Swedish mapping, cadastral and land registration authority) and the Norwegian one is situated at the Norwegian Mapping Authority. The 2020–2024 review was performed in good collaboration between the two nations. The purpose of the review is to provide an up-to-date and orderly documentation of the boundary and how it is marked. The boundary markers have all been restored, painted yellow and measured with GNSS and network RTK. The five-metre-wide clearing has been secured (below the tree line) and made free of trees and shrubs. The work has especially in uninhabited mountainous areas been a challenge both logistically and physically.

In some places, the stretch of the boundary has had to be clarified or slightly changed. These locations are mainly located on the southern part of boundary, where it occasionally passes through lakes and along watercourses. The clarifications especially in lakes are important for the documentation of the review. The main source will be a digital file with all information of the boundary, together with coordinates and their locational uncertainties. The documentation of the review is about to be submitted to the Swedish and Norwegian governments and it has been a privilege to work with such a peaceful boundary.

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1. HISTORICAL BACKGROUND TO THE SWEDISH-NORWEGIAN NATIONAL BOUNDARY

Sweden and Norway are situated in the northern part of Europe and the national boundary on land between them is about 1634 kilometres long. The boundary is the longest national boundary on land in Europe and it is mentioned as early as during the 11th century in the saga of Saint Olaf. The process of international boundary making consists of delimitation and demarcation (Srebro (ed.), 2013). The stretch of the boundary between Sweden and Norway started to be more formally defined in the 17th century. The southernmost section of the boundary, about 30 kilometres long, was established in 1661 through something called the Nasselbacka treaty, but no demarcation was done by that time. The treaty was signed by Sweden and Denmark-Norway according to the peace in Roskilde in 1658.

The remaining part of the boundary is dealt with in the detailed Strömstad treaty from 1751, which also is a treaty between Sweden and Denmark-Norway. This treaty, incidentally, also deals with a large part of the current national boundary between Norway and Finland. During the boundary demarcation that followed 1752–1766, 349 boundary markers were erected. The main part of these markers consists of about 1.5 metres high stone cairns. Centred in the cairns are flat stones vertically erected, bearing engraved royal monograms of the Swedish King Adolf Fredrik and the Danish-Norwegian Kings Fredrik V (monograms from 1752–1765) and Christian VII (monograms from 1766), see Figure 1.

The tri-state point between Sweden, Norway and Finland was established in 1809, when Finland no longer was a part of Sweden. A stone cairn was erected at the site in 1897–1898 and it is located between boundary marker no 293 and no 294. The cairn at the tri-state point was re-built in 1926 and then given a concrete layer. A few stone cairns were also erected during the 19th century along the so far unmarked southernmost section of the boundary.

The landscape along the Swedish-Norwegian boundary varies from deep forests to mountainous areas high above the tree line. There are a lot of lakes and creeks in the area. Occasionally along the southern part of the boundary, the boundary line passes through some of these lakes and runs along some of these creeks. The boundary line is otherwise defined as straight lines between the boundary markers. According to the Strömstad treaty from 1751, there should also be a 16-cubits-wide (approximately 10 metres) clearing along the boundary line (below the tree line) that should be free of trees and shrubs.

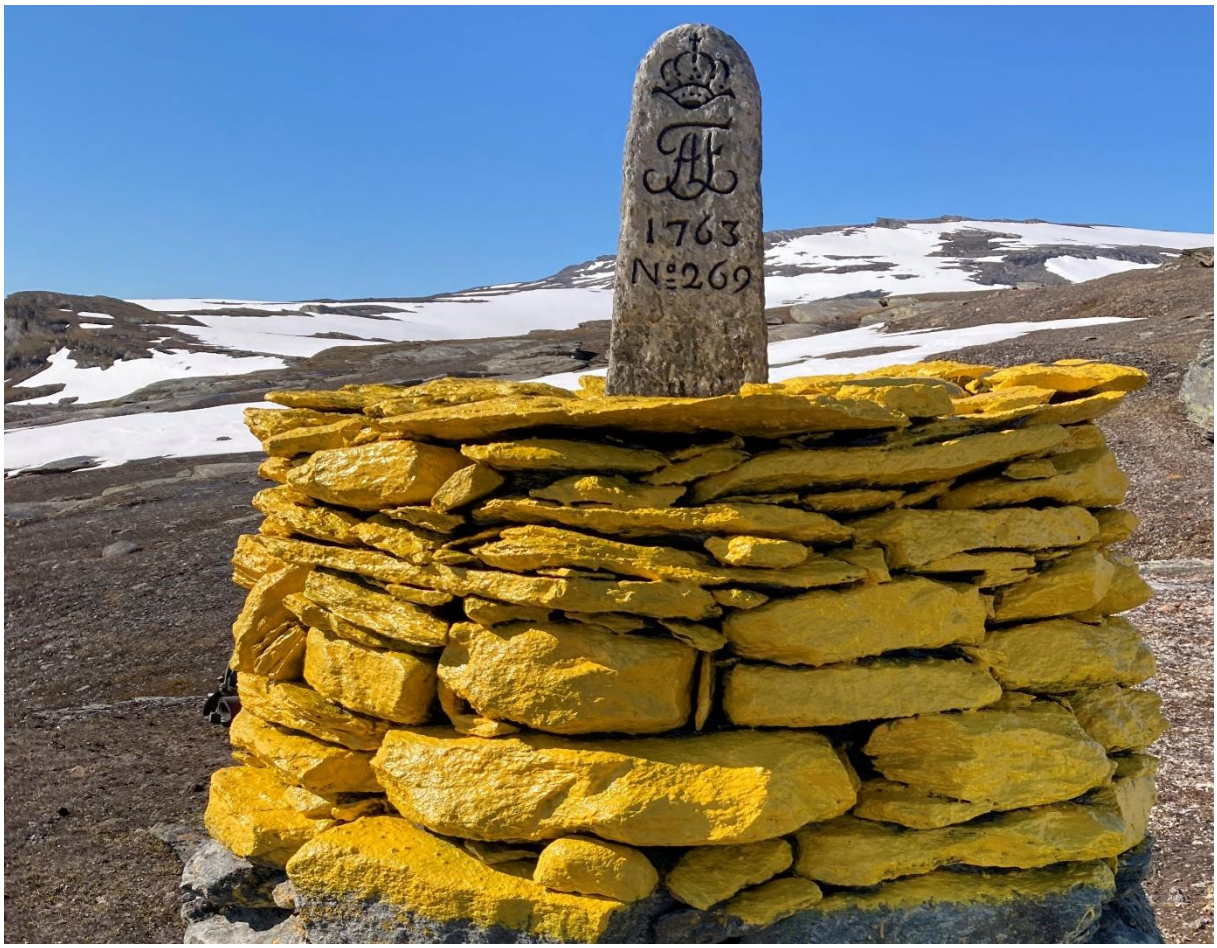

Figure 1: *The main part of those boundary markers that were erected during the 18th century consists of about 1.5 metres high stone cairns with flat stones with engraved royal monograms. The Swedish side bear the monogram of King Adolf Fredrik, as here on boundary marker no 269.*

2. MANAGEMENT OF THE SWEDISH-NORWEGIAN NATIONAL BOUNDARY

There is a long-term perspective in the Strömstad treaty from 1751 in the sense that it states that the markers on the national boundary between Sweden and Norway should be maintained on a regularly basis. It is also stated that the boundary clearing should be kept open. These reviews of the boundary are after an agreement between Sweden and Norway in 1933 nowadays carried out with an interval of about 25 years. The work during the reviews is performed by boundary commissions, specially appointed by the Swedish and Norwegian governments respectively. The reviews of the national boundary between Sweden and Norway during the 20th century were carried out 1929–1930, 1959–1962 and 1984–1987, see Figure 2.

Figure 2: *Captain J H von Krusenstierna and Major P A Grinaker were Swedish and Norwegian boundary commissioners during the review of the boundary 1929–1930, here standing in front of boundary marker no 76.*

The Strömstad treaty is the base for how the work with restoring boundary markers etcetera should be done during the reviews. After a decision in 1957, the boundary clearing is nowadays however limited to a width of five metres (2.5 metres into each country). The reviews are carried out jointly by the two nations and the purpose is to provide an up-to-date and orderly documentation of the national boundary's location and how it is marked.

To reduce the distance between neighbouring boundary markers, the number of boundary markers has increased significantly during the reviews carried out in the 20th century. Some new boundary markers have also been erected to replace creeks with straight lines. The remaining parts where the boundary line passes through lakes or runs along watercourses (mainly creeks) are approximately 76 kilometres long, see Figure 3.

Figure 3: *In some parts, the boundary line runs along creeks, occasionally indicted by sign posts saying that the boundary line follows the creek ("Riksgränsen följer bäcken").*

Today, the total number of boundary markers defining the boundary is 641. 610 of them are stone cairns and the remaining points are marked by natural stones (seven of them), memorial monuments (four of them), wooden poles with signs (19 of them) and also one steel bolt. Ten breakpoints along the boundary line are still unmarked, mainly due to their location in water. To better visualise the boundary line in the terrain, several hundreds of sign posts where roads and hiking trails cross the boundary and smaller cairns are also erected. These markers do however not define the stretch of the boundary line. All these kinds of markers are if needed also restored during the reviews. With a start during the review 1959–1962, the upper part of all stone cairns has been painted yellow.

The most recent review of the national boundary between Sweden and Norway was conducted 2020–2024. The work has been finalised and the documentation is about to be submitted to the Swedish and Norwegian governments. After the submission of the documentation, the process for the final approval of the review will start.

3. THE REVIEW OF THE NATIONAL BOUNDARY BETWEEN SWEDEN AND NORWAY 2020–2024

3.1 Organisation

The boundary commissions for the review of the national boundary between Sweden and Norway 2020–2024 were appointed by the Swedish and Norwegian governments in 2018–2020. Together with these appointments, a general instruction for the execution of the review was enclosed. The Swedish boundary commission is situated at Lantmäteriet (the Swedish mapping, cadastral and land registration authority) and it consists of Susanne Ås Sivborg (head boundary commissioner), Martin Lidberg (boundary commissioner), Dan Norin (geodetic expert and secretary) and Per Sörbom (cadastral information expert). The Norwegian boundary commission is located at the Norwegian Mapping Authority, and it consists of Johnny Welle (head boundary commissioner), Anders Østeraas (boundary commissioner and secretary) and Tor Erik Bakke (technical expert), see Figure 4.

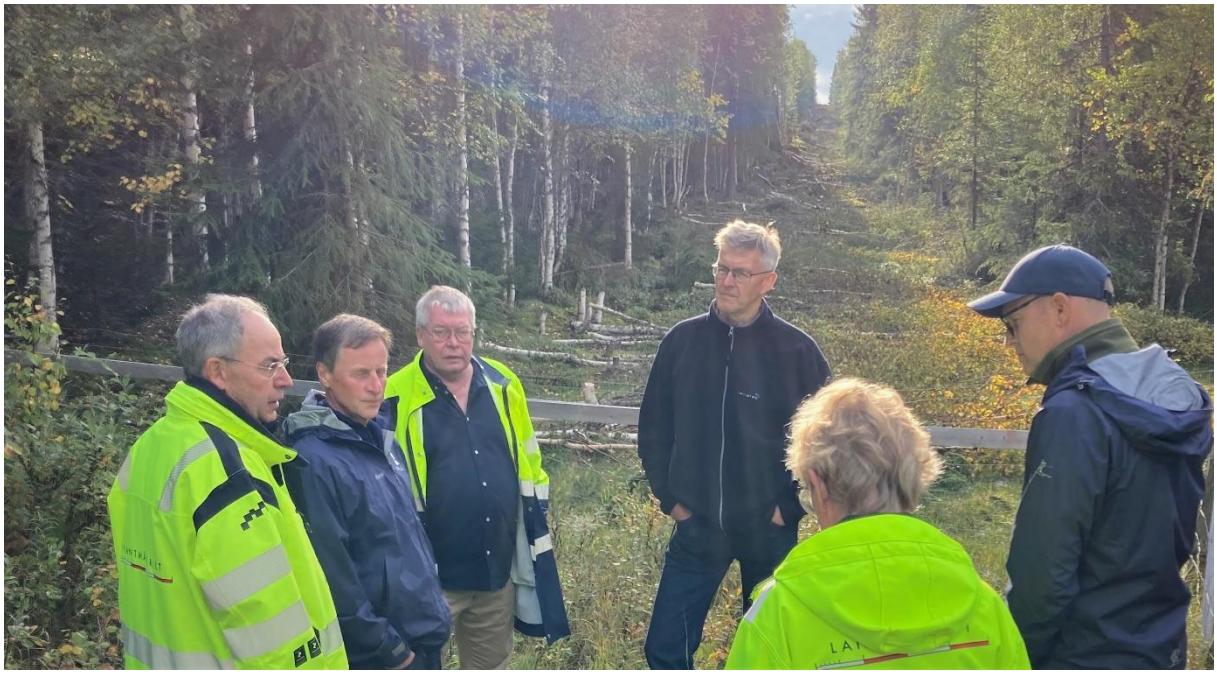

Figure 4: *The members of the Swedish and Norwegian boundary commissions standing in the five-metre-wide clearing along the boundary line close to boundary marker no 192.*

Resources from Lantmäteriet and the Norwegian Mapping Authority have been used during the work with the review. Practically, Sweden was responsible for the work on the northern part of the boundary and Norway on the southern part. More detailed instructions for the field work have jointly been worked out by the two commissions. A lot of questions of general nature have also been treated.

Many meetings and informal contacts through e-mail have been the ground for the good collaboration in a friendly atmosphere. Each country has also had good opportunities to inspect the work performed by the other side.

3.2 Field work

Since many parts of the boundary are remotely located, it was a challenge both logistically and physically to carry out the field work. Among the long stretches in uninhabited mountainous areas, transportation by helicopter has been a necessity. The preparations prior to the actual field work have been extensive. Special permits for landing and working in natural protected areas were obtained from county administrative boards. A continuous contact during the field work with the local Sami population regarding reindeer farming was a necessity. Contacts with different authorities were needed and all used equipment had to be declared through customs control. Information in advance was sent out to property owners along the boundary. Another challenge was to be able work during the covid-19 pandemic, when special permissions from authorities were needed to be able to cross the boundary.

The field work during the review of the national boundary between Sweden and Norway 2020–2024 has been extensive, see Figure 5:

- All boundary markers and other markers were cleaned and if necessary restored (a rough estimated is that over 1000 tons of stones were lifted by hand).
- The upper part of all stone cairns was painted yellow (a rough estimate is that around 3000 litres of paint have been used).
- The engraved royal monograms were filled in with black paint.
- 18 flat stones with the engraved royal monograms were found broken and they were replaced with newly produced ones, bearing engraved royal monograms of the Swedish King Carl XVI Gustaf and the Norwegian King Harald V.
- Only two new stone cairns were erected, where one is a boundary marker that defines the boundary.
- Worn out signs on signs post were replaced with new ones.
- The five-metre-wide clearing was secured (below the tree line) and made free of trees and shrubs, where the centreline prior to the work was staked out.
- All boundary markers were surveyed.

The GNSS-based network RTK services from Lantmäteriet (Swepos) and the Norwegian Mapping Authority (CPOS) were mainly used for staking out the boundary line and for measuring the boundary markers, see Figure 6. Since mobile Internet connection was partly inexistent, post-processing was used in these areas, either through static measurements or through processing with virtual RINEX files. In some areas, also single-station RTK was used. The boundary markers that define the boundary were for redundancy reasons measured three times with at least 15 minutes separation between each measurement.

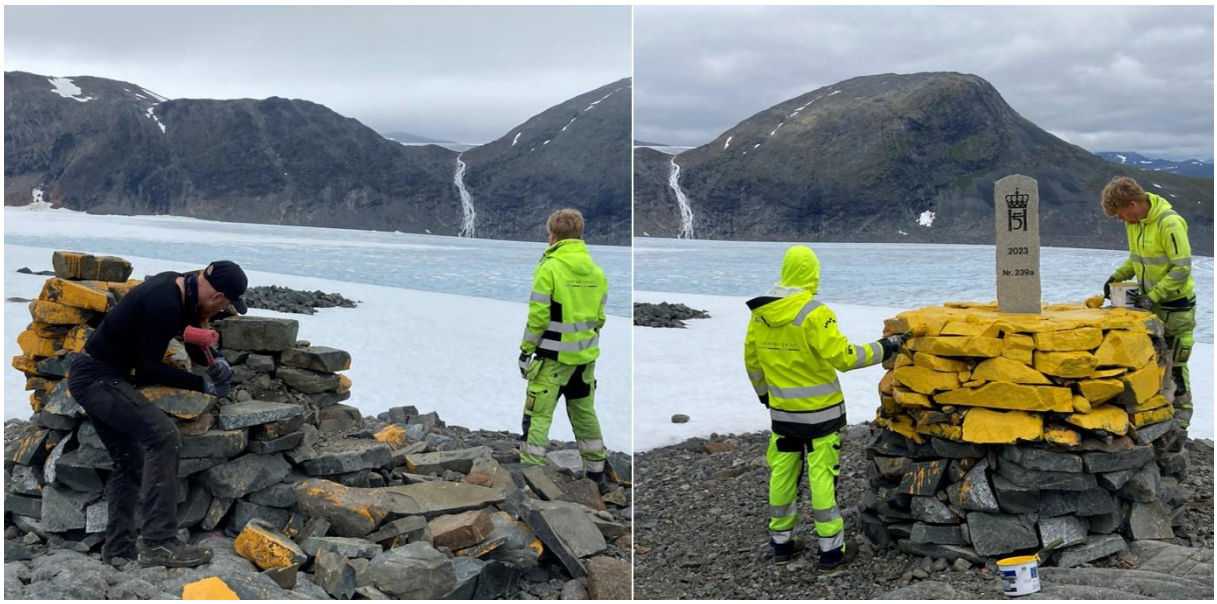

Figure 5: *Boundary marker no 239a had by snow and hard weather been destroyed including the flat stone with the engraved royal monograms and the need for restoration was huge.*

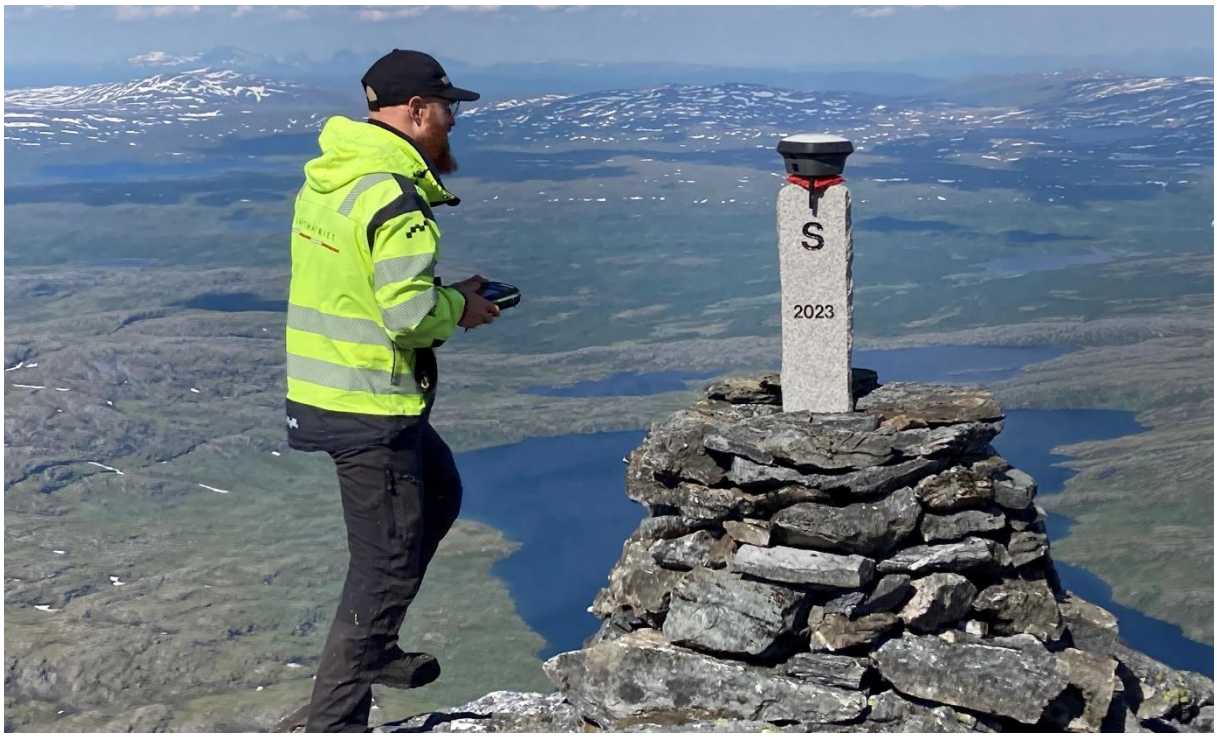

Figure 6: *A small stone cairn as a boundary marker that do not define the boundary has been erected on the highest point along the boundary (1752 metres above mean sea level), here surveyed with network RTK by Swedish field engineer Karl Tirén.*

3.3 Documentation

The review of the national boundary between Sweden and Norway 2020–2024 is the first one where the official documentation will be digital. All information about the boundary is available in a digital file that is created in the format Geography Markup Language (GML). The file will be the official documentation for public use until the next review in about 25 years. It contains the various boundary markers with coordinates and their respective locational uncertainties. It is also the basis for other documentation that visualise the central information in the GML file, such as a text-based description of the boundary, individual descriptions with photographs of each boundary marker and maps of the boundary's stretch in lakes and watercourses, see Figure 7.

Until now, the official source for the boundary's stretch in lakes and watercourses has been the maps produced during the review of the national boundary between Sweden and Norway 1959–1962. These are paper maps with the boundary line drawn more or less with a pen with quite large uncertainty. With the new digital representation, a large quality improvement in the definition of the boundary line in lakes have been achieved. The locational quality in the coordinates of the boundary markers have through surveying also been highly improved. The locations of the stone cairns in the terrain are however still defining the boundary, but the description of the boundary in geographical data and in the cadastral index maps will be highly improved through the improved coordinates. The national boundary is according to legislation also representing county, municipal and property boundaries. All these four boundaries must coincide. The review of the national boundary consequently also affects the cadastral property register.

The new digital representation of the boundary also leads to a need for clear definitions of the boundary line in its transition from lakes to creeks and to straight lines. Until now, both the maps showing the boundary line in creeks and lakes from the review 1959–1962 and the text documentation from the review 1984–1987 are occasionally a bit unclear in this sense. Joint field visits at these locations by members of the two boundary commissions have therefore been needed. The result is a clear definition of the boundary in all locations. The stretches of the watercourses have also been controlled. In a few locations, there have been a need to define break points with coordinates and in one location a new boundary marker that defines the boundary has been erected, see Figure 7 and 8.

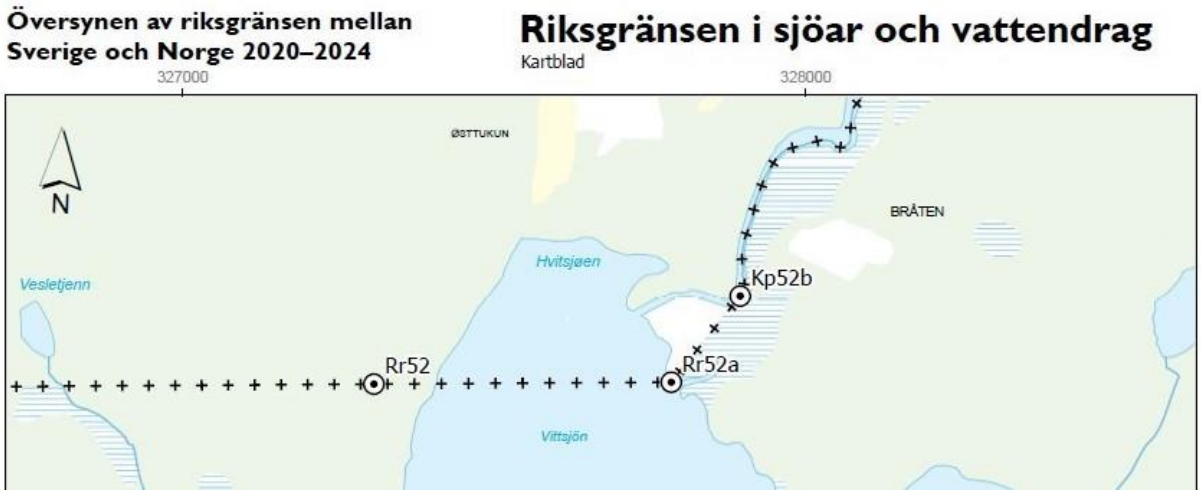

Figure 7: *The boundary line goes as a straight line from boundary marker no 52 to 52a where a new stone cairn has been erected and then as a straight line to a point defined by coordinates (52b) in a creek, which the boundary line from there on follows northwards.*

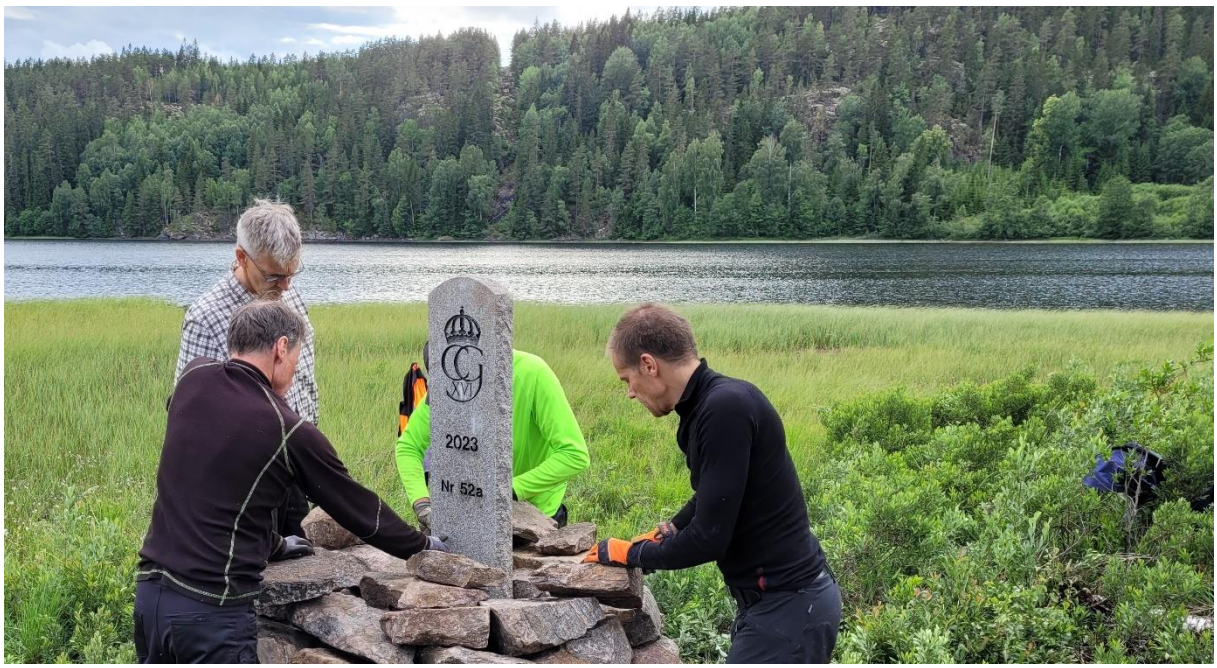

Figure 8: *One new boundary marker that defines the boundary has been erected during the review of the boundary 2020–2024. The work with building the cairn was performed through joint efforts by Tor Erik Bakke, Anders Østeraas, Martin Lidberg and Dan Norin from both boundary commissions. The boundary marker is designated 52a and the location is in a break point that so far only has been defined in earlier maps. Boundary marker no 52 is visible on the other side of the lake in the boundary clearing.*

4. FUTURE ASPECTS

By finalising the extensive work with the review of the national boundary between Sweden and Norway 2020–2024, the boundary line is clarified and well-documented, which is useful for both different authorities and the public. The old boundary markers which are true cultural heritage have been looked after. The review also contributes in keeping the peaceful relation between the two countries intact. With many years to go before the next review, the goal is also to enter an agreement of maintenance that in firsthand can enable continuous work with the clearing along the boundary line.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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BIOGRAPHICAL NOTES

Dan Norin graduated with a M.Sc. with main courses in geodesy and photogrammetry from the Royal Institute of Technology in Stockholm in 1991. He has during 1991–1996 and since 2002 been working as a geodesist at Lantmäteriet – the Swedish Mapping, Cadastral and Land Registration Authority. During 1996–2002, he was employed at the Stockholm City Planning Administration as a geodetic expert. He holds the position as geodetic expert and secretary in the Swedish boundary commission for the review of the national boundary between Sweden and Norway 2020–2024.

Anders Østeraas graduated with main courses in surveying and photogrammetry from the Norwegian University of Life Sciences in Ås 1989. He has during 1989–1990 and since 1995 been working as an engineer at Kartverket – the Norwegian Mapping Authority. During 1991–1995, he was employed at the municipality of Meråker as an engineer. He holds the position as boundary commissioner and secretary in the Norwegian boundary commission for the review of the national boundary between Norway and Sweden 2020–2024. He also holds the position as secretary in the Norwegian boundary commission for the review of the national boundary between Norway and Finland to be finalised 2025 and he was also a

member of the Norwegian boundary commission for the review of the national boundary between Norway and Russia that was finalised in 2018.

Martin Lidberg is head of the Department for Geodetic Infrastructure at Lantmäteriet – the Swedish Mapping, Cadastral and Land Registration Authority. He graduated with a M.Sc. with main courses in geodesy and photogrammetry from the Royal Institute of Technology in Stockholm in 1988 and got his PhD from Chalmers University of Technology in Gothenburg in 2007. He has worked at Lantmäteriet since 1988. He is since 2019 the chairman of EUREF and since 2022 he is the president of the Nordic Geodetic Commission (NKG). He holds the position as boundary commissioner in the Swedish boundary commission for the review of the national boundary between Sweden and Norway 2020–2024.

Tor Erik Bakke graduated with main courses in building, construction and surveying from Narvik College of Engineering in 1981, and with additional course in surveying from Gjøvik College of Engineering in autumn 1984. He has from 1982 until today been working as an engineer at Kartverket – the Norwegian Mapping Authority. He holds the position as technical expert in the Norwegian boundary commission for the review of the national boundary between Norway and Sweden 2020–2024. He is also leading the field work for the review of the national boundary between Norway and Finland to be finalised 2025 and he also participated as a field assistant in the review of the national boundary between Norway and Sweden 1984–1987.

Mikael Lilje is head of the International Department at Lantmäteriet – the Swedish Mapping, Cadastral and Land Registration Authority. He has worked for more than 30 years at Lantmäteriet, mainly at the Department for Geodetic Infrastructure. He has also been involved in FIG for more than 25 years and among several positions, he was vice President for the period 2017–2024.

CONTACTS

Mr Dan Norin
Lantmäteriet
SE-801 82 Gävle
SWEDEN
Tel.: +46 26633745
Email: dan.norin@lm.se
Web site: www.lantmateriet.se

Mr Anders Østeraas
Norwegian Mapping Authority
Kartverket Trøndelag, Postboks 600 Sentrum
NO-3507 Hønefoss

NORWAY
Tel.: +47 32118495
Email: anders.osteraas@kartverket.no
Web site: www.kartverket.no

Mr Martin Lidberg
Lantmäteriet
SE-801 82 Gävle
SWEDEN
Tel.: +46 26633842
Email: martin.lidberg@lm.se
Web site: www.lantmateriet.se

Mr Tor Erik Bakke
Norwegian Mapping Authority
Kartverket Nordland, Postboks 600 Sentrum
NO-3507 Hønefoss
NORWAY
Tel.: +47 32118768
Email: tor.erik.bakke@kartverket.no
Web site: www.kartverket.no

Mr Mikael Lilje
Lantmäteriet
SE-801 82 Gävle
SWEDEN
Tel.: +46 26633742
Email: mikael.lilje@lm.se
Web site: www.lantmateriet.se