Liikenne- ja viestintävirasto
Transport- och kommunikationsverket
Finnish Transport and Communications Agency

Impact evaluation of the Porokello alert service

Satu Kotituomi, Matti Huju, Risto Kulmala, Ahti Lahtela

Traficomin tutkimuksia
ja selvityksiä
Traficoms
forskningsrapporter
och utredningar
Traficom Research Reports

9/2019

Co-financed by the Connecting Europe Facility of the European Union

TRAFICOM
Liikenne- ja viestintävirasto

Julkaisun päivämäärä
18.4.2019

Julkaisun nimi
Selvitys Porokello-varoitusjärjestelmän vaikutuksista

Tekijät
Satu Kotituomi, Matti Huju, Risto Kulmala, Ahti Lahtela

Toimeksiantaja ja asettamispäivämäärä
Liikenteen turvallisuusvirasto (Trafi), 8.11.2018

Julkaisusarjan nimi ja numero
Traficomin tutkimuksia ja selvityksiä 9/2019

ISSN(verkkojulkaisu) 2342-0294
ISBN(verkkojulkaisu) 978-952-311-327-5

Asiasanat
porovaroitus, porokolari, poro-onnettomuus, poro, poronhoitoalue, vaikutusten arviointi, liikenneturvallisuus, tiedotuspalvelu

Tiivistelmä
Porokolareita on viimeisen vuosikymmenen aikana tapahtunut vuosittain 3300–4500 kpl. Porokolarien vuosittaisen määrän vaihteluun vaikuttaa porojen liikkuminen, johon puolestaan vaikuttavat mm. sääolot ja porojen ravintotilanne. Kolareiden alueellinen ja ajallinen vaihtelu on suurta. Eniten kolareita tapahtuu loppukesästä ja loppusyksystä.

Tämän työn tavoitteena oli selvittää, onko Porokello-varoitusjärjestelmä vaikuttanut liikenneturvallisuuteen ja porokolareiden määrään, sekä antaa suosituksia, jotka johtaisivat palvelun käytettävyyden ja laadun parantumiseen ja siten liikenneturvallisuusvaikutusten kasvuun.

Työssä oli käytettävissä poronhoitoalueen porokolariaineisto vuosilta 2011–2018, tarkat aika- ja paikkatiedot Porokellolla annetuista varoituksista Porokellon käyttöönotosta 10/2016 lähtien sekä varoittajina toimineiden ammattikuljettajien ajoreittidata. Lisäksi työssä haastateltiin asiantuntijoita, aktiivisille varoittajille järjestettiin työpajoja sekä varoittajille ja Porokello-sovelluksen käyttäjille laadittiin internet-kyselytutkimus.

Tilasto- ja karttatarkastelujen pohjalta voidaan todeta, että poro-onnettomuuksien määrät ja poro-onnettomuusaste ovat olleet alhaisempia Porokellon käyttöönoton jälkeen. Varoitukset ovat oletettavasti yksi tekijä myönteiseen turvallisuuskehitykseen.

Internet-kyselyissä noin 9/10 kuljettajista kertoi varautuneensa ja muuttaneensa ajotapaansa Porokello-varoituksen saatuaan. Suurimmat vaikutukset ajotavassa koettiin tarkkaavaisuuden lisäämisessä sekä ajonopeuden alentamisessa. Saadut vastaukset tukevat käsitystä siitä, että Porokellon varoitukset vaikuttavat tätä kautta porokolareihin ja yleiseen liikenneturvallisuuteen.

Varoittajia tarvittaisiin liikenteeseen nykyistä enemmän ainakin loppuiltapäivästä, iltaisin, viikonloppuisin ja lomakausina, jolloin varoituksia annetaan kolarimääriin nähden suhteessa muita ajankohtia vähemmän. Porokello-sovellusta on suositeltavaa kehittää ja markkinoida aktiivisesti jatkossakin, jotta palvelulle saataisiin lisää varoituksia vastaanottavia käyttäjiä ja sitä kautta porovaroituksille enemmän vaikuttavuutta.

Yhteyshenkilö
Anna Schirokoff

Raportin kieli
suomi

Luottamuksellisuus
Julkinen

Kokonaissivumäärä
148

Jakaja

Kustantaja
Liikenne- ja viestintävirasto Traficom

TRAFICOM
Transport- och kommunikationsverket

Utgivningsdatum

18.4.2019

Publikation
Utredning om effekterna av varningssystemet Porokello

Författare
Satu Kotituomi, Matti Huju, Risto Kulmala, Ahti Lahtela

Tillsatt av och datum
Trafiksäkerhetsverket (Trafi), 8.11.2018

Publikationsseriens namn och nummer
Traficoms forskningsrapporter och utredningar 9/2019

ISSN (webbpublikation) 2342-0294
ISBN (webbpublikation) 978-952-311-327-5

Ämnesord
renvarning, renolycka, ren, renskötselområde, konsekvensbedömning, trafiksäkerhet, informationstjänst

Sammandrag
Under det senaste årtiondet har det inträffat 3300–4500 renolyckor per år. Variationen i antalet krockar per år påverkas av renarnas rörelser, vilket i sin tur påverkas av väderförhållanden och renarnas näringssituation. Den regionala och tidsmässiga variationen är stor. Flest krockar sker på sensommaren och senhösten.

Målet med detta arbete var att utreda om varningssystemet Porokello har påverkat trafiksäkerheten och antalet renolyckor samt att ge rekommendationer som leder till en förbättring av tjänstens användbarhet och kvalitet och därmed en större inverkan på trafiksäkerheten.

Tillgängligt material i arbetet var material om renolyckor i renskötselområdet för åren 2011–2018, exakta tid- och platsuppgifter om varningar från Porokello sedan varningssystemet togs i bruk 10/2016 samt data från yrkesförares färdskrivare som fungerat som varnare. I arbetet intervjuades dessutom sakkunniga, workshoppar ordnades för aktiva varnare och en webbenkät genomfördes bland varnare och användare av appen Porokello.

Utifrån granskningar av statistik och kartor kan man konstatera att antalet renolyckor och renolycksgraden har varit lägre efter att Porokello togs i bruk. Varningarna är en väsentlig faktor mot en positiv säkerhetsutveckling.

I webbenkäten uppgav cirka 9/10 förare att de hade förberett sig och ändrat sitt körsätt efter att ha fått en varning från Porokello. Varningarna påverkade körsättet främst genom ökad uppmärksamhet och sänkt körhastighet. De erhållna svaren stöder uppfattningen om att varningar från Porokello på detta sätt inverkar på renolyckor och den allmänna trafiksäkerheten.

Det skulle behövas fler varnare i trafiken, åtminstone på seneftermiddagen, kvällar, veckoslut och i semestertider då det ges färre varningar i förhållande till antalet krockar än vid andra tidpunkter. Det rekommenderas att Porokello-appen utvecklas och marknadsförs aktivt i fortsättningen så att varningarna når ut till fler användare och därmed ger renvarningarna större effekt.

Kontaktperson	Språk	Sekretessgrad	Sidoantal
Anna Schirokoff	finska	Offentlig	148

Distribution	Förlag
	Transport- och kommunikationsverket Traficom

TRAFICOM
Finnish Transport and Communications Agency

Date of publication
18.4.2019

Title of publication
Impact evaluation of the Porokello alert service

Author(s)
Satu Kotituomi, Matti Huju, Risto Kulmala, Ahti Lahtela

Commissioned by, date
Finnish Transport Safety Agency (Trafi), 8.11.2018

Publication series and number
Traficom Research Reports 9/2019

ISSN (online) 2342-0294
ISBN (online) 978-952-311-327-5

Keywords
reindeer warning, reindeer collision, reindeer accident, reindeer, reindeer husbandry area, impact assessment, traffic safety, information service

Abstract
Over the last decade there have been from 3,300 to 4,500 collisions with reindeer each year. The variation in the annual number of reindeer collisions depends on the movement of reindeer, which in turn is affected by weather conditions and the availability of food for reindeer. The variation in the location and timing of collisions is large. Most collisions occur at the end of the summer and the end of the autumn.

The objective of this study was to investigate whether the Porokello (reindeer bell) alert system has had an impact on traffic safety and the number of reindeer collisions, and to make recommendations to improve the usability and quality of the service and thus increase its impact on traffic safety.

The data examined in this study consisted of data on reindeer collisions in reindeer husbandry areas from 2011 to 2018, exact time and location data of alerts given by Porokello since the adoption of the system in October 2016, as well as route data of the professional drivers who gave warnings. In addition, the study included interviews with experts, workshops for those active in giving warnings, and an online survey for those giving warnings and for users of the Porokello application.

On the basis of examination of statistics and maps, it can be seen that the number of reindeer accidents and the reindeer accident rate have decreased since the introduction of Porokello. The alerts are likely to be one factor in the positive development of safety.

In online surveys, approximately 9 out of 10 drivers said that they had taken precautions and changed their driving behaviour after receiving a reindeer alert. The biggest reported impact on driving behaviour was the increase in alertness and reduction of driving speed. The responses received support the notion that the alerts have an impact on reindeer collisions and general traffic safety.

More people giving warnings in traffic are needed at least during late afternoon, in the evenings, weekends and during holiday periods when there are fewer alerts in relation to the number of collisions than at other times. It is recommended that the Porokello application be further developed and actively marketed in the future to increase the number of users receiving alerts and thereby increase the effectiveness of the alerts.

Contact person	Language	Confidence status	Pages, total
Anna Schirokoff	Finnish	Public	148

Distributed by	Published by
	Finnish Transport and Communications Agency Traficom

ALKUSANAT

Porokolareita on viimeisen vuosikymmenen aikana tapahtunut vuosittain keskimäärin noin 4000 kpl. Porokolarien ehkäiseminen on osoittautunut haastavaksi tehtäväksi. Vuosina 2013–2015 kokeiltiin ensimmäistä kertaa paikkatietoa ja mobiiliteknologiaa yhdistävää porovaroituspalvelua. Myöhemmin palvelu sai nimekseen Porokello. Vuonna 2016 palvelu sai paljon uusia varoittajia, ja vuonna 2017 Porokello tuli kaikkien tienkäyttäjien saataville Porokello-sovelluksen myötä. Varoittaja- ja käyttäjämäärät ovat kasvaneet voimakkaasti viime aikoina, joten palvelun vaikutusten arviointi tuli ajankohtaiseksi.

Porokello oli vuosina 2016–18 Lapin ELY-keskuksen hallinnoima tutkimus- ja kehityshanke, joka toteutettiin Liikenneviraston rahoituksella. Vuoden 2019 alussa Porokello hanke siirtyi Lapin ELY-keskuksen alaisuudesta Lapin Liiton hallinnoimaksi EU-rahoitteiseksi (maaseuturahasto) hankkeeksi. Palvelun tuottamiseen osallistuu vuoden 2019 alusta myös yksityinen toimija Osuuspankki (OP). Hankkeessa ovat mukana myös Paikkatieto Online Oy, HHR Business Oy, Paliskuntain yhdistys, Lapin ELY-keskus, V-Traffic ja DNA Oyj.

Selvitys on laadittu Liikenne- ja viestintäviraston toimeksiannosta Traficon Oy:ssä, jossa työstä vastasivat Satu Kotituomi, Matti Huju ja Risto Kulmala. Lisäksi Aapo Tiilikainen osallistui Internet-kyselyn toteuttamiseen ja vastausten käsittelyyn. Ahti Lahtela Paikkatieto Online Oy:stä on vastannut paikkatietoaineiston käsittelystä ja karttojen tuottamisesta. Työtä ohjasivat Anna Schirokoff Liikenne- ja viestintävirastosta ja Henna Nurminen HHR Business Oy:stä. Työtä ja raporttia kommentoi Matti Särkelä Paliskuntain yhdistyksestä. Eliisa Lintula ja Laura-Maria Vuolo HHR Business Oy:stä ovat avustaneet työpajojen järjestämisessä.

Tämä selvitys on osa EU:n tukemaa NordicWay2-hanketta, jossa Suomen, Ruotsin, Norjan ja Tanskan tieviranomaiset kehittävät yhteistyössä yritysten, tutkimuslaitosten, ajoneuvovalmistajien ja palveluntarjoajien kanssa tieliikenteen automaatiota ja yhteistoiminnallisia järjestelmiä (C-ITS) pohjoismaisissa olosuhteissa.

Helsingissä, 1. huhtikuuta 2019

Anna Schirokoff
Johtava asiantuntija
Liikenne- ja viestintävirasto Traficom

FÖRORD

Under det senaste årtiondet har det i genomsnitt inträffat cirka 4000 renolyckor per år. Att förebygga renolyckor har visat sig vara en utmaning. Under åren 2013–2015 testades för första gången en renvarningstjänst som kombinerar geografisk information och mobilteknik. Senare fick tjänsten namnet Porokello. År 2016 fick tjänsten många nya varnare och år 2017 blev Porokello tillgänglig för alla trafikanter via appen med samma namn. Antalet varnare och användare har ökat kraftigt den senaste tiden och därför blev bedömningen av tjänstens effekter aktuell.

Mellan åren 2016–2018 var Porokello ett forsknings- och utvecklingsprojekt som drevs av NTM-centralen i Lappland med finansiering från Trafikverket. I början av 2019 flyttades projektet från NTM-centralen till Lapplands förbund och blev ett projekt med EU-finansiering (landsbygdsfonden). Från början av 2019 deltar även Andelsbanken (OP) som privat aktör i att producera tjänsten. I projektet deltar även Paikkatieto Online Oy, HHR Business Oy, Paliskuntain yhdistys, NTM-centralen i Lappland, V-Traffic och DNA Abp.

Utredningen har gjorts på uppdrag av Transport- och kommunikationsverket vid Traficon Ab där Satu Kotituomi, Matti Huju och Risto Kulmala ansvarade för arbetet. Därutöver deltog Aapo Tiilikainen i genomförandet av webbenkäten och behandlingen av svaren. Ahti Lahtela vid Paikkatieto Online Oy har ansvarat för att hantera geografisk information och skapa kartor. Arbetet styrdes av Anna Schirokoff på Transport- och kommunikationsverket och Henna Nurminen på HHR Business Oy. Arbetet och rapporten har kommenterats av Matti Särkelä på Paliskuntain yhdistys. Eliisa Lintula och Laura-Maria Vuolo på HHR Business Oy har hjälpt till att ordna workshopparna.

Denna utredning är en del av det EU-stödda projektet NordicWay2 där vägmyndigheterna i Finland, Sverige, Norge och Danmark i samarbete med företag, forskningsinstitut, fordonstillverkare och tjänsteleverantörer utvecklar automatiseringen av vägtrafiken och samverkande system (C-ITS) i nordiska förhållanden.

Helsingfors, den 1 april 2019

Anna Schirokoff
Ledande sakkunnig
Transport- och kommunikationsverket Traficom

FOREWORD

Over the last decade, there have been about 4,000 collisions with reindeer each year. Preventing reindeer collisions has proved to be challenging. During 2013–2015, a reindeer alert service that combined location data and mobile phone technology was trialled for the first time. The service was later given the name Porokello (reindeer bell). In 2016, the service gained many new people giving warnings and in 2017 it was made available to all road users through the Porokello application. As the numbers of people giving warnings and using the application have recently greatly increased, now was a good time to evaluate the impact of the service.

From 2016 to 2018, Porokello was a research and development project managed by the ELY Centre for Lapland. It was implemented with the aid of funding from the Finnish Transport Agency. At the beginning of 2019, the Porokello project was transferred from the ELY Centre for Lapland to be managed by the Regional Council of Lapland as an EU-financed project (funded by the European Agricultural Fund for Rural Development). Since the beginning of 2019, a private actor, the OP cooperative bank (OP), has also been involved in delivering the service. Others involved in the project are Paikkatieto Online Oy, HHR Business Oy, the Reindeer Herders' Association, the ELY Centre for Lapland, V-Traffic and DNA Oyj.

The study was commissioned by the Finnish Transport and Communications Agency and carried out by Traficon Oy. At Traficon Oy, the work was carried out by Satu Kotituomi, Matti Huju and Risto Kulmala, and Aapo Tiilikainen participated in implementing the online survey and in processing the responses. Ahti Lahtela from Paikkatieto Online Oy was responsible for processing the location data and for producing the maps. The work was directed by Anna Schirokoff from the Finnish Transport and Communications Agency and Henna Nurminen from HHR Business Oy. Matti Särkelä from the Reindeer Herders' Association commented on the work and the report. Eliisa Lintula and Laura-Maria Vuolo from HHR Business Oy helped in organising the workshops.

This report is part of the NordicWay2 project, supported by the EU. In the project, the Finnish, Swedish, Norwegian and Danish road authorities are collaborating with companies, research institutes, vehicle manufacturers and service providers to develop Cooperative Intelligent Transport Systems (C-ITS) for Nordic conditions.

Helsinki, 1 April 2019

Anna Schirokoff
Chief Adviser
Finnish Transport and Communications Agency Traficom

Contents

Concepts

Term	Definition
Breeding reindeer	A reindeer that is not slaughtered in the autumn.
ADT	Average daily traffic means the sum of traffic volumes on all days of the year divided by the number of days in that year.
User	A person who can receive alerts but not give warnings.
Transport performance	The total number of kilometres driven by vehicles in the area under scrutiny in a year. Unit [vehicle-kilometre/year].
Road traffic accident loss assessor	In this report, a road traffic accident loss assessor refers to a reindeer herder selected by a general meeting of the reindeer herders' cooperative having signed a declaration referred to in section 51 of the Reindeer Husbandry Act. After being informed of a collision by the police, the assessor visits the scene of the reindeer collision to verify the collision report, writes down the details of the parties to the collision, submits a loss report and informs the owner of the reindeer. The assessor also sees to putting down the reindeer and disposing of the carcass.
Porokello/Porokello app	An app for receiving reindeer alerts. The app is available for Android and iOS phones with a Finnish user account and navigators that support V-Traffic.
Porokello Pro	A dedicated alert phone handed out by the Porokello service to professional drivers that can be used to both give warnings and receive alerts.
Reindeer accident rate	Number of reindeer accidents per transport performance. Unit [accidents/100 million vehicle-kilometres].
Reindeer accident density/reindeer collision density	Number of reindeer accidents or collisions per 100 road kilometres a year. Unit [accidents or collisions/100 road kilometres/year].
Road section	A stretch of the road network of a certain length created in the context of this study for the purposes of statistical analysis of Porokello's impacts and visualisation of key figures.
Road segment	Identification data in the road address system which, together with an individual road number, forms the basis of road numbering. The roads have been divided into road segments using division points, which typically are junctions. A single road segment may contain several road sections used in the impact assessment of the Porokello service.
Person giving warnings	A person who can give reindeer warnings using a Porokello Pro alert phone or the Varottaja app.

Warning/reindeer warning	Indication given by a person giving warnings issued using a Porokello Pro alert phone or the Varottaja app after seeing a reindeer. The system saves the indication's time stamp and location. The users and persons giving warnings receive an alert through their apps or alert phones if they arrive closer than a given distance to the location for which an alert was issued. In March 2019, the alerts remained valid for half an hour within a 750 m radius of the location from which the warning was issued.
Alert density	Number of reindeer alerts per road kilometre in a certain period. Unit e.g. [alerts/road kilometre/year].
Varottaja app	An app which can be downloaded to Android and iOS phones. Registered users can use this app to both give warnings and receive alerts.

1 Introduction

1.1 Background

Over the last decade there have been from 3,300 to 4,500 collisions with reindeer each year. On the basis of expert assessments, the cost of repairs to vehicles damaged in collisions with reindeer amounts to about 15-20 million euros a year (Särkelä 2019). About 2.5 million euros a year are paid to reindeer owners in compensation for animals killed in collisions. Reindeer collisions also cause additional problems for reindeer owners and result in losses for transport companies for the time the vehicles cannot be used on the roads. Reindeer collisions rarely result in injury to people.

The variation in the annual number of reindeer collisions depends on the movement of reindeer, which in turn is affected by weather conditions and the availability of food for reindeer. The variation in the location and timing of collisions is large. Most collisions occur at the end of the summer and the end of the autumn.

Preventing reindeer collisions has proved to be challenging. Tests have been carried out with reflective collars, painting their antlers, mobile traffic signs and clearing roadsides. However, these have not had a significant impact on the number of reindeer collisions and the risk of collision. (Ollila 2018)

During 2013-2015, a reindeer alert service that combined location data and mobile phone technology was trialled for the first time. The professional drivers that took part in the experiment exchanged alerts using smart phones permanently mounted in their vehicles. In 2016, the service was expanded and given the name Porokello. Initially, 1,000 phones were given to professional drivers who could give and receive alerts. In 2017, alerts could be sent to other road users in reindeer husbandry areas using the Porokello application. In 2018, the service was expanded by the addition of the Varottaja (Warner) application, which enabled people to give alerts using their own telephone when they were on leisure trips, too.

The number of people giving warnings and using the Porokello application has recently greatly increased, so now is a good time to evaluate the impact of the service.

Several studies into the factors affecting reindeer collisions have been produced. Several publications have also been produced about the Porokello service and its impact. The main publications are

- Kinnunen, T. & Simonen, M. (2011). Porokolarit ja niiden vähentäminen. (Reindeer collisions and reducing them.) ELY Centre for Lapland.
- Aittoniemi, E. & Rämä, P. & Penttinen, M. (2015). Ajantasaisen porovaroituspalvelun hyväksyttävyys ja vaikutukset – ammattikuljettajien kenttätutkimus poronhoitoalueella. (Acceptability and impact of real time reindeer warning service - field research on professional drivers in reindeer husbandry area.) Traficom research reports 17/2015
- Turpeenniemi, J. (2017). Porokello-hankkeen jatkuvuus. (Continuity of the Porokello project.) Lapland University of Applied Sciences thesis.
- Timo-Huhtala, M. (2018). Porokello – porovaroittaminen liikenteessä älyteknologia avulla, loppuraportti 2016 – 2017. (Porokello - reindeer alerts in

traffic using smart technology, final report 2016 - 2017). ELY Centre for Lapland reports 4/2018.

The impact of a previous trial reindeer warning service, that worked on a similar principle to the Porokello service, was examined in an earlier study ”Ajantasaisen porovaroituspalvelun hyväksyttävyys ja vaikutukset - ammattikuljettajien kenttätutkimus poronhoitoalueella” (Acceptability and impact of real time reindeer warning service - field research on professional drivers in reindeer husbandry area). In the study carried out at that time into the impact of the reindeer warning service, driver surveys and interviews were carried out along with expert assessment and interviews with reindeer herders and other stakeholder groups. The source data available for the study was considerably more limited than now as the service was used on only two stretches of road and there were few users of the service. The experiment used 40 warning telephones and the driver interview findings were based on 35 interviews.

The 2015 study estimated that the reindeer warning system could reduce reindeer collisions by 10 to 18% if all drivers were able to receive the alerts, and those providing the warnings were professional drivers in the region and others who drove because of their jobs. The reindeer warning system was also seen to have an indirect effect on traffic safety. The service does not just have an impact on reindeer collisions, but also on general traffic safety as after they receive an alert, drivers are more watchful and reduce their driving speeds. The impact of the service on all accidents involving personal injury in reindeer husbandry areas is estimated at 0.8 to 1.5%, which corresponds to 2 to 4 accidents involving personal injury a year. (Aittoniemi et al 2015).

1.2 The objectives of the study and procedures

The objective of this work is to investigate whether the Porokello warning system had an impact on traffic safety, and to make recommendations which will result in improvements to the availability and quality of the service, and thus to an increase in its impact on traffic safety.

The data examined in this study consisted of data on reindeer collisions in reindeer husbandry areas from 2011 to 2018, exact time and location data of alerts given through Porokello since the adoption of the system in October 2016, as well as route data of the professional drivers who gave warnings. The data was used to identify the characteristics of how the service is used as well as to analyse whether the service has had a statistically significant impact on reindeer collisions.

In addition, the study included surveys with users and interviews with experts. Workshops were organised for those active in giving warnings, and online surveys were drawn up for those giving warnings and users of the Porokello application.

This study had statistical data available that was considerably broader and covered a longer period than the data used in the 2015 study. The study aimed to support the 2015 study by making further evaluations of the impact Porokello has had on traffic safety and finding ways of increasing its effectiveness.

The study attempted to answer the following questions:

- What impact has the Porokello service had on the number of reindeer collisions? The annual variation in reindeer collisions is large because of such things as environmental conditions.
- What would the optimal number of alerts be, and where should they be targeted so that the safety impact of the service is as great as possible?
- What would the optimal number of people giving warnings be so that the safety impact of the service is as great as possible? Is there a need to increase the number of people in the service giving warnings, and if so what professional groups and regions would it be appropriate to target?
- How long should the alerts last for and how large an area should they cover?

The study concentrated above all on evaluating the safety impact of the Porokello service and the opportunities to further increase its effectiveness. The characteristics of reindeer collisions or other ways of reducing reindeer collisions were not evaluated in depth, because there are other, relatively recent studies dealing with this subject.

2 Reindeer husbandry and reindeer collisions

2.1 Reindeer husbandry area and reindeer herders' cooperatives

Reindeer husbandry is an ancient industry in the north that plays a key role in the culture and traditions of the northern parts of the country. Reindeer husbandry is an important creator of employment, especially in remote areas, and its economic impacts are significant. (Reindeer Herders' Association 2019).

The reindeer husbandry area is the area designated for reindeer herding in the Reindeer Husbandry Act (848/1990). The size of this area is 123,000 square kilometres, or 36% of Finland's surface area. As shown in Figure 1, the reindeer husbandry area comprises the province of Lapland (excluding the region of Kemi-Tornio) and the northern parts of North Ostrobothnia and Kainuu regions. (Reindeer Herders' Association 2019a).

Approx. 200,000 reindeer roam the reindeer husbandry area in winter, and after the calving season in summer, this figure may be as high as 340,000 animals (Finnish Road Safety Council 2019).

For the reindeer husbandry area on the map, see Figure 1.

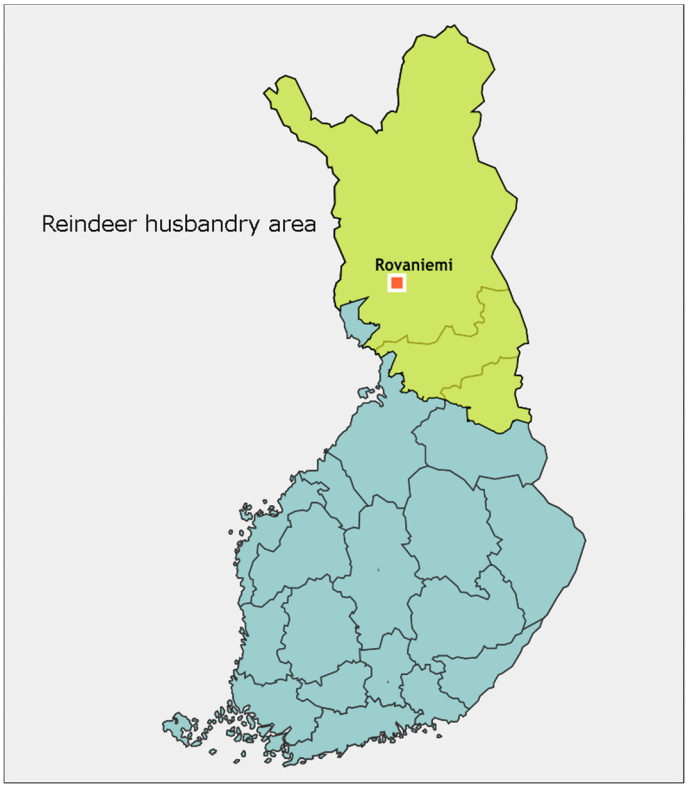


Figure 1. Finnish reindeer husbandry area. Source: Reindeer Herders' Association.

The Finnish reindeer husbandry area is divided into 54 reindeer herders' cooperatives (Figure 2). The cooperatives, which are units of varying surface areas and with different reindeer numbers, are responsible for managing the reindeer in their areas. (Reindeer Herders' Association 2019a).

There are major variations in the methods of reindeer husbandry both between and within the reindeer herders' cooperatives. Factors affecting these methods include

the established techniques and culture of managing the reindeer as well as topographical aspects. The southern part of the reindeer husbandry area is predominated by forests and also has plenty of other settlement. The northern part, on the other hand, is scarcely populated with open terrain and many fells. Feeding reindeer in pens in winter is common in the southern and central parts of the reindeer husbandry area. While the reindeer are kept in pens, fewer than average animals are found on the sides of the roads.

For a map of the reindeer herders' cooperatives, see Figure 2.

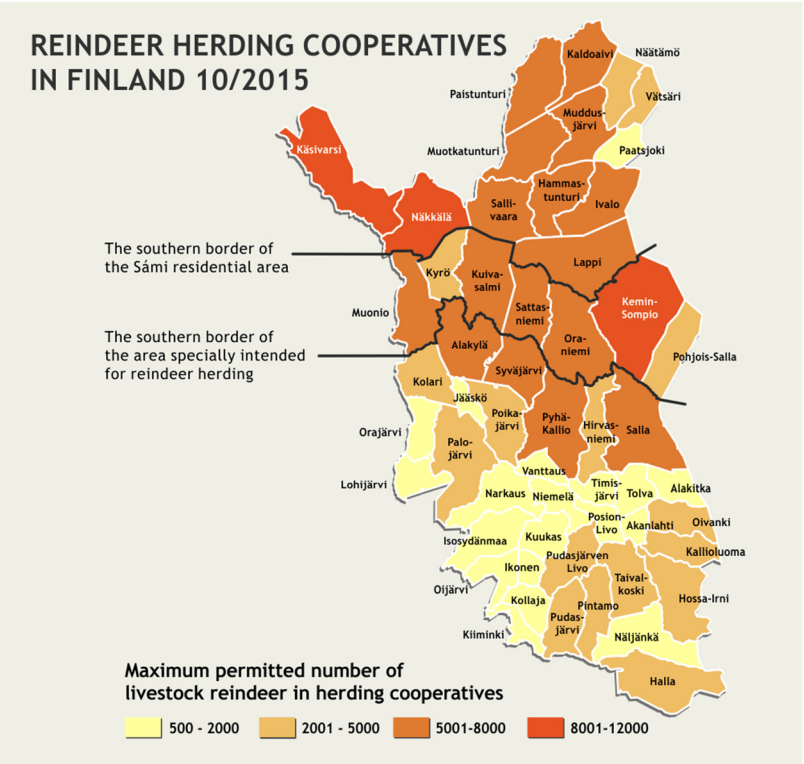


Figure 2. Reindeer herders' cooperatives on the map. Source: Reindeer Herders' Association.

2.2 Reindeer herding year and reindeer movements

2.2.1 Reindeer movements

Factors that affect reindeer movements and animal numbers on the roadsides include the season, time of the day, light levels, weather, food availability and reproductive cycles. Reindeer cover long distances in search of food. They often follow familiar natural trails in places where they need to cross a road to access their feeding grounds. Reindeer may cross the road at the same point several times a day. In late summer and early autumn they move actively, mainly in search of fungi.

In the summer reindeer favour such open and windy areas as roads to escape from insects that bother them. As the evenings get darker in late summer, their new dark coats make reindeer more difficult to see (Kinnunen, Simonen 2011). In the mating season in the autumn the reindeer move around, gathering into herds. With deep snows in winter, the ploughed roads draw reindeer out of the forest, and when salt is spread on icy roads, reindeer come out to lick the salt.

2.2.2 Reindeer herding year

The reindeer herding year begins in early June. The animals spend the summer grazing freely. The calves are born in spring and follow their mothers out in the open. The unpredictable behaviour of calves (and thus also their mothers) is a factor that increases the collision risk. Most calves are marked during the summer, while some are marked as the reindeer are sorted in the autumn.

The mating season begins in late September and lasts until October or November. In the autumn, the reindeer are rounded up and sorted. The animals to be sent for slaughter are listed, and breeding reindeer are counted and recorded. Approx. 80,000 reindeer are slaughtered annually. After the animals going for slaughter have been separated, some 200,000 breeding reindeer remain in the reindeer husbandry area. (Reindeer Herders' Association 2019a and 2019b). The migration from autumn pastures to winter grazing areas is seen as an increased number of reindeer on the roadsides.

The reindeer are less active in winter. The soft snow cover impedes their movements. Some reindeer herders start feeding their animals in the forest or keep them in pens over the winter months. The time at which the reindeer are gather in pens varies annually depending on the weather conditions.

"The first of May sees calves in the snow", as the saying goes. Pregnant females mainly give birth in May. In spring, 120,000 to 130,000 reindeer calves are born. As the calving season approaches, some reindeer herders gather their females into calving pens, letting them out after they have given birth. In most cases, however, the reindeer give birth out in the open and find their own way to their accustomed calving areas. (Reindeer Herders' Association 2019a and 2019b).

Figure 3. Reindeer herding year. Photo: Reindeer Herders' Association. Text in top-right corner: Three most significant events of the reindeer herding year are calving, summer ear-marking of calves and reindeer round-up. During winter, reindeer are herded and their well-being is ensured according to natural conditions. The reindeer herding year begins on 1 June. In yellow: Calving – Calves are born. In green: Ear-marking of calves. In orange: Reindeer round-up.

2.3 Incidence and reporting of reindeer collisions

Over the last decade, there have been between 3,300 and 4,500 reindeer collisions each year. They rarely cause personal injuries to road users. According to the Finnish Transport Infrastructure Agency's accident register, two fatal reindeer collisions took place in 2011–2018, both in 2014. According to preliminary data, no fatal reindeer collisions occurred in 2018. (Rajamäki 2019.)

A study conducted in 2011 (Kinnunen & Simonen 2011) indicates that almost all (96%) reindeer collisions are sustained by Finnish motorists. According to this study, a car was a party to 60% of reindeer collisions.

After a collision with a reindeer, the driver should always report the incident to the Emergency Response Centre without delay. This way, the police will be informed and can alert the road traffic accident loss assessor. Since summer 2018, passing on a report of a collision directly from the Emergency Response Centre to the assessor in an SMS message has been tested in the areas of a few reindeer herders' cooperatives. (Kotila and Heiskari 2018.)

Once the road traffic accident loss assessor has been informed of the collision, they attempt to reach the road user who was party to the collision by phone and write down the exact scene and time of the accident, the number of reindeer involved in the collision, their condition, and the data of the driver and the vehicle. The assessor visits the scene of the collision to verify the report, puts down the reindeer and disposes of the carcass.

Identifying the scene of a reindeer collision is often difficult even if the driver of the vehicle involved in the collision could be reached by telephone. The road user often only calls in the collision after reaching the nearest lay-by or some other safe place to stop, and even if they use the 112 app, the coordinates are not necessarily correct for the scene of the accident. The assessor is often unable to locate the scene of the accident, either because of inaccuracies in the report or, if a collision has taken place, the potentially injured reindeer is already far from the road. (Kotila and Heiskari 2018.)

Regrettably often road users fail to report a reindeer collision at all. In the case of HGVs, a partial reason for this may be that the driver does not necessarily even notice the collision. Such reindeer collisions either go unrecorded in the statistics, or if a carcass is only found later, the time of the collision remains unclear.

The road traffic accident loss assessor or the person appointed to this task in each cooperative saves the data on each reindeer collision to the ePoro system, which also supports mobile use. The available data on each collision report received by the assessor or on dead reindeer found in the vicinity of the road, presumably killed in a traffic accident , are saved to the ePoro system. The data are saved regardless of whether or not the assessor has managed to verify the incident on site. The time and location (on the map) of the collision are always saved to the report, even if they were inaccurate.

The map function of ePoro has been in use since August 2014. Earlier, the scenes of reindeer collisions were saved as a verbal description rather than by clicking on the map, and consequently they were less accurate than the current data as a rule.

The Finnish Motor Insurers' Centre pays reindeer herders compensation for animals lost in collisions. The compensation value is determined for each reindeer species based on the mean weight, average price per kg and a breeding coefficient (Reindeer Herders' Association 2019a). Compensation is only paid for those reindeer whom the assessor believes to have died as a result of a collision and on whom an accident report has been saved to ePoro.

Any damage to the vehicle that hit a reindeer is covered by the elk damage insurance of a voluntary vehicle insurance policy. While motorists have to pay a policy excess, they do not lose their no claims bonus. Any personal injuries resulting from a reindeer collision are covered by the motor vehicle liability insurance.

2.4 Factors affecting reindeer collisions

The numbers, times and locations of reindeer collisions vary greatly from year to year. However, the annual distribution of collisions typically is the same: the collision numbers peak in late summer and early winter (Figure 4). Peaks in collision numbers can often be observed in certain areas in certain times of the year.

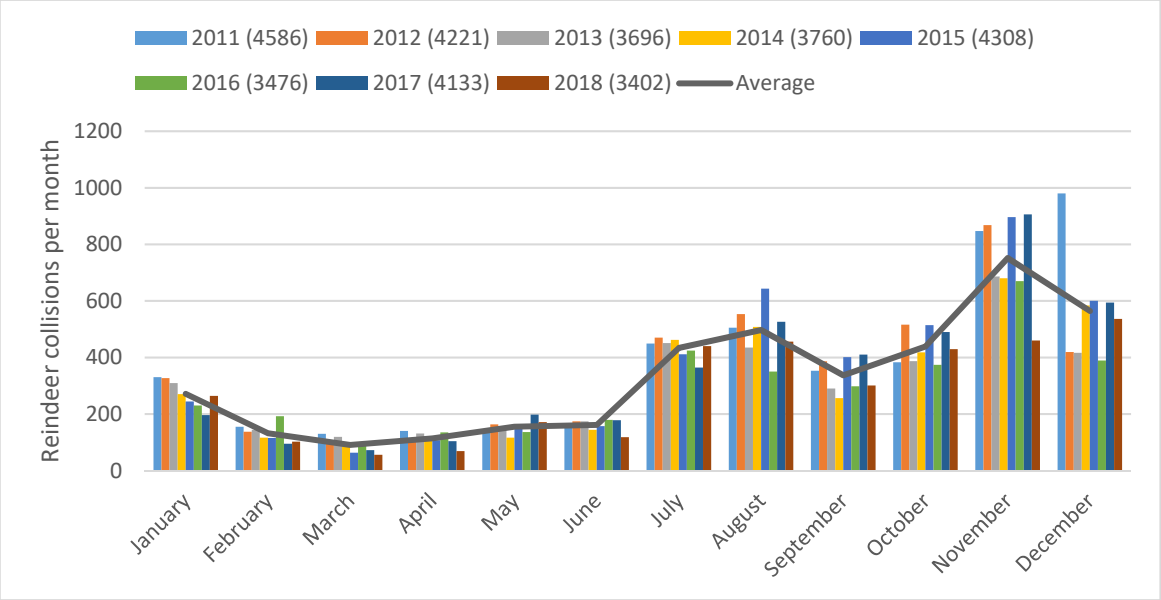


Figure 4. Monthly numbers of reindeer collisions in 2011–2018.

The reindeer usually go around in herds, which means that several reindeer are found on the road or close to it at the same time.

Many factors have a bearing on reindeer collisions and their numbers. These factors include at least:

- Reindeer husbandry practices
  - Keeping reindeer in pens and the times at which they are gathered into pens and released:
    - The collision risk is higher at the times when reindeer are being gathered into and released from pens, as the animals are likely to move around more.
    - While they are kept in pens, fewer reindeer are wandering around than during the rest of the year.
  - Winter feeding of reindeer:

        - The winter feeding of reindeer affects their need to move from area to area in search of food.
    - Fences between reindeer herders' cooperatives and pasture rotation fences within the cooperatives.
        - The fences restrict reindeer movements.
        - Higher numbers of collisions may occur at road-fence junctions.
- The lifestyle and movements of reindeer
    - Reindeer numbers in the terrain and on roadsides vary annually and seasonally. This factor is discussed in section 2.2.
- Weather and road conditions
    - Snow volume:
        - Heavy snows to some extent draw reindeer to ploughed roads as getting around in the forest is more difficult.
    - Weather and road conditions:
        - Slippery roads and poor visibility increase the risk of reindeer collisions.
    - Impacts of weather conditions on the reindeer's food sources:
        - The food situation varies from year to year. In 2017, for instance, the summer was cold. In the autumn, the reindeer actively move from one grazing area to the next in search of fungi and other food to build up fat reserves.
- In June and July, the reindeer are pestered by blood-sucking insects, including horseflies, gnats, midges, biting midges etc.
    - The reindeer become restless, and the time they can spend feeding is shortened. Warm weather makes the insect problem worse.
    - The reindeer make their way to open and windy areas, including fens, fells or roads. The heat radiating up from the asphalt transport the carbon dioxide and heat secreted by the reindeer up, making it more difficult for the insects to find the animals.
    - When the insect season is particularly severe, reindeer may put on short bursts of speed to get rid of the insects pestering them. This is different from their usual way of moving and may take a driver by surprise (Reindeer Herders' Association 2019a).
- Traffic volumes and driving speeds
    - Traffic volumes vary depending on the time of the year and day, holiday seasons or events. At Easter and Christmas, for example, the traffic volumes go up. During the holiday seasons the roads are used by tourists who are not necessarily aware of the need to watch out for reindeer or familiar with areas with a high collision risk to the same extent as the locals.
    - Motorists drive far too fast in poor weather or visibility conditions.
- Road maintenance techniques
    - Spreading of salt on roads:
        - Reindeer are drawn to the roads to lick the salt.
        - Depending on the conditions, the spreading of salt may make the roads more or less slippery, affecting the collision risk.
    - Speed limits:
        - At higher speeds, the driver's observation time is reduced and avoiding reindeer is more difficult.

The importance of the different factors influencing collisions in year-to-year variations of collision numbers are difficult to estimate.

3 Porokello

3.1 Operating principle

Porokello alerts drivers to a high risk of reindeer collisions in the reindeer husbandry area. Porokello warnings are given by Porokello users, and the alerts issued are based on a visual observation of reindeer on the road or in its vicinity. When they see a reindeer, the person giving the warning uses either a dedicated alert phone or an app downloaded on their personal phone.

The reported location data of the reindeer is saved to the cloud. The alert is valid for 30 minutes within a 750 metre radius of the location where it was given. Road users receive the alerts through their Porokello mobile apps or navigators when reaching the area the alert concerns. The persons giving warnings can see the warnings given by others on their devices.

Figure 5. Operating principle of Porokello. Image: porokello.fi

3.2 Current status description

From 2016 to 2018, Porokello was a research and development project managed by the ELY Centre for Lapland. It was implemented with the aid of funding from the Finnish Transport Agency. At the beginning of 2019, the Porokello project was transferred from the ELY Centre for Lapland to be managed by the Regional Council of Lapland as an EU financed project (funded by the European Agricultural Fund for Rural Development). Since the beginning of 2019, a private actor, the OP cooperative bank (OP), has also been involved in delivering the service. Other stakeholders involved in the project are Paikkatieto Online Oy, HHR Business Oy, the Reindeer Herders' Association, the ELY Centre for Lapland, V-Traffic and DNA Oyj.

Three different applications of Porokello are currently in use:

- Porokello Pro app
  - an app used by professional drivers
  - the app can be used to give warnings and receive alerts with a dedicated and individualised alert phone handed over to drivers
- Varottaja app
  - an app for invited and registered users

    - the app can be used to give warnings and receive alerts on the user's personal phone
- Porokello app
    - can be used on Android and iOS phones with a Finnish user account and navigators that support V-Traffic
    - does not require registration
    - the app can only be used to receive alerts but not to give warnings

The first Porokello Pro alert phones were distributed to professional drivers in summer 2016. By the end of 2016, approx. 1,000 alert phones had been handed out. Of these, some 400 were in active use at the end of 2018. Since 1 April 2018, 540 new persons have joined the system from other professional groups and give warnings through the Varottaja app. Among these two groups, persons actively giving warnings totalled approx. 350 a day (situation in January 2019). Of these, those using the alert phones accounted for approx. 85% and those using the Varottaja app on their personal phones for approx. 15%.

The Porokello mobile app for private motorists has been in use since September 2017. In addition to reindeer alerts, the app provides instructions on what to do in case of a reindeer collision. It also has a map view that shows valid alerts in real time. Since the beginning of November 2016, the alerts have also been displayed by the latest navigator models as V-Traffic data and in the integrated navigation systems for cars that use the V-Traffic service. (Timo-Huhtala 2018). The alerts are also shown on the Internet on a map displayed at porokello.fi.

The Porokello app has been downloaded some 65,000 times in total. The app has some 300 to 600 daily users.

4 Data and methodology

4.1 Collision and alert data used in the study and the processing of data

4.1.1 Collision and alert data

Reindeer collision data

The study used collision data obtained from the Finnish Motor Insurers' Centre, which were reported to the Centre using the ePoro system. The data content on reindeer collisions comprises the coordinates of the collision site, the time and date of the incident and the reindeer herders' cooperative in which the site is located. The database contains over 31,500 reindeer collisions going back to early 2011. The data used in the study contain all reindeer collisions reported to the system by 23 January 2019.

In 2011–2015 the location was given for approx. 75% of the collisions, and in 2017–2018 for 92% on average. However, the reindeer herders' cooperative in which the site is located has been recorded for all collisions. The percentage of collisions for which the location is given also varies greatly between different cooperatives, as does the accuracy of the location. The locations of older collisions are based on verbal descriptions. The current ePoro system has a map interface in which you can click on the map to indicate the collision site. Some road traffic accident loss assessors check the GPS coordinates of the site. In practice, however, the person entering the data in the ePoro system may not be the assessor, in which case the location may be given as a verbal description.

Alerts

The data content of the alerts comprises the ID of the person giving the warning, coordinates for the alert area central point, the radius of the alert area as well as the alert's time of validity. The data obtained from the Porokello Pro app also contain the company that owns the phone, waypoint coordinates at four-minute intervals, waypoint time stamps and daily user numbers.

Other data

The data from the Varottaja app contains the user's phone number, the user's most recent location (retained for at maximum 10 minutes), the time of the user's most recent login, and daily user numbers.

The data from the Porokello app contains the user's most recent location (retained for at maximum 10 minutes), the time of the user's most recent login, and daily user numbers.

Alert data containing all alerts are available from the time the Porokello trial began in June 2016.

Initially, an alert was valid for an hour. On 27 June 2018, this time was shortened to half an hour. As an exception, the road accident loss assessors of the reindeer herders' cooperatives can put four-hour alerts in place using the Varottaja app.

Driving routes of persons giving warnings

Waypoints of the driving routes of persons giving warnings with the Porokello Pro app are saved every four minutes. This makes it possible to estimate how often such persons are found on various road sections.

4.1.2 Processing of the data

General points

All reindeer collisions having taken place and alerts given were included in the study. The impact of the alerts was studied using data from 2017 and 2018, in which years Porokello was widely used. Data from 2016 were excluded from the analysis, as Porokello was introduced in the middle of that year, and the number of persons giving warnings increased gradually during the year.

Due to uncertainties related to the accuracy of collision site locations, the study could not presume that the collisions had taken place at the exact locations indicated by the coordinates. Consequently, all collisions for which the location was known were allocated to road sections when processing the data. The road sections are segments of the road network created for the statistical analyses and visualisations of this report. One road segment in the road address system may contain several road sections used in this study.

The data were processed in different ways to assess the safety impacts of Porokello. The study also wished to establish where and when alerts were given, and how the times, locations and numbers of the alerts should be improved to enhance their safety impacts. To assess these factors, the accident frequency and rate of reindeer collisions (below referred to as reindeer accident density and reindeer accident rate) were calculated, and the temporal and geographical distribution of collisions, alerts and persons giving warnings was studied by means of calculations and map presentations. See below for a more detailed description of the assessment methods.

Reindeer accident density and rate

A reindeer accident density and rate were calculated separately for each road section in the reindeer husbandry area. The analysis includes sections with road numbers <= 9999. As the data allocated to road sections only include collisions whose locations are known, collisions whose locations are not known were allocated to the road sections using coefficients. The coefficient was determined based on the percentage of collisions whose location was known in each reindeer herders' cooperative.

The reindeer accident density and rate were examined before and after the Porokello alert system was introduced, which is why collision data for 2011–2015 were also included in the analysis. To allocate collisions whose location is not known to road sections, the percentages of collisions whose site is known in the reindeer herders' cooperatives were also used in this data (the average in 2011–2015).

The alert numbers on the examined road sections were also included in the analyses of reindeer accident density and rate. The changes in reindeer accident density and rate were analysed with reference to road class, traffic volume (ATD) and speed limits.

Temporal and geographical distribution of reindeer collisions and alerts

The distribution of all reindeer collisions that occurred and alerts that were given in 2017 and 2018 was studied regarding the following aspects:

- monthly distribution
- distribution by hour of the day
- distribution by day of the week
- variations by month and time of the day
- variations by day of the week and time of the day
- variations in collisions and alerts by month and reindeer herders' cooperative
- variations in collisions and alerts by day of the week and reindeer herders' cooperative.

Map analyses

Maps were also used to illustrate the geographical and temporal variations in reindeer collisions, reindeer alerts, driving routes of persons giving warnings and the accident rate. Map presentations were used in an effort to find road sections with a high reindeer collision risk and to assess the proportions between collision density and alert density, thus identifying areas where and times when more alerts are needed.

The road sections with the highest collision densities (collisions/km) were determined based on collision data. The road sections with the highest alert densities (alerts/km) were determined based on alert data. The road sections with the highest collision and alert densities were displayed on maps on the basis of the following factors:

- by hour (in 3-hour periods)
- by day of the week (Monday–Friday, Saturday, Sunday)
- by quarter (the months were divided in to groups of three based on similar reindeer collision properties: January–March, May–June, July–September, October–December).

The road sections with high collision densities and alert densities (the top 20%) are shown on the maps in colour.

The road sections with the greatest reindeer accident rates (top 20%), are also shown on a map.

The map analyses include collisions and alerts from 2017 and 2018. The collisions whose locations are known and the alerts issued were allocated with the accuracy of a road section. The analyses include sections with road numbers <=9999.

4.2 Workshops and expert interviews

As part of the study, workshops were organised in Kuusamo on 29 November 2018 and in Rovaniemi on 20 December 2018. Users of both the Porokello Pro app and the Varottaja app participated in the workshops, which charted the practices of persons giving warnings and the impacts of an alert on driving behaviour. Factors motivating persons who give alerts were also investigated, and the reason for the numbers of reindeer collisions continuing to be high despite traffic safety work and Porokello was considered. The results of the workshops were used to support other research methods in assessing the impacts of the Porokello alert system and also the

formulation of questions for an Internet survey. Valuable feedback for planning the development of Porokello was also received at the workshops.

In addition, a reindeer herder and two road accident loss assessors were interviewed. The interview with the reindeer herder (Maununiemi 2018) provided information on reindeer behaviour and reindeer herding techniques. The interviews with the assessors provided information on practices related to reindeer collisions and an idea of the current status of the ePoro system.

4.3 Internet surveys

Internet surveys for persons giving warnings and Porokello app users were prepared using the Webropol survey tool. The questionnaires are attached to this report. The survey was carried out by sharing a public online link with persons giving Porokello warnings and app users. A link to the survey intended for persons giving warnings was e-mailed to all Varottaja app users. Information about the survey and a link to it were sent to persons giving warnings through their employers. The survey was also marketed on the Porokello app, Porokello website and the social media. The respondents could take the survey between 20 December 2018 and 27 January 2019.

The surveys contained about 50 questions. Some of the survey questions addressed to persons giving warnings and app users were different. The majority were multiple choice questions. Open-ended answers could be given to some questions, or freely worded additional information could be provided.

The Internet survey was used to study impacts on driving behaviour based on the drivers' subjective assessment. The survey also charted the advantages and disadvantages of the service as well as ideas for developing it. The Internet survey additionally produced research data for measuring the acceptability of the service.

The questions addressed to both groups were divided into three parts, as was done in a previous study (Aittoniemi et al. 2015). The same groupings were used to enable comparisons between the studies. The contents of the parts were as follows:

Part 1 – background questions

- the respondent’s driving habits in the reindeer husbandry area and the distance they drive annually
- ownership of reindeer
- occupation if a professional driver (survey for persons giving warnings)
- practice of giving warnings (survey for persons giving warnings)
- habits of using Porokello, experiences of alerts
- motivation for using Porokello (persons giving warnings)
- two of the most recent reindeer collisions if any
- general impacts of the Porokello alert system on driving behaviour (user survey)

Part 2 – receiving an alert

The respondents were asked to recall the latest incident when they received a Porokello alert. The respondents were asked to describe the incident verbally, and in the context of this incident, they were asked about their observations of reindeer and the impacts of the reindeer alert on their driving behaviour.

Part 3 – general questions about Porokello

- satisfaction with Porokello
- acceptability of the service
- views concerning areas with not enough persons giving warnings and the duration of an alert
- opinions on who could be allowed to give alerts
- advantages and disadvantages of the Porokello alert system and ideas for developing it.

5 Findings

5.1 Statistical examination

The temporal and geographical variation in reindeer collisions, reindeer alerts, driving routes of persons giving warnings and traffic volumes was illustrated using tables and graphs in an attempt to identify the relationships between these factors and to assess the impacts of the Porokello alert system on safety.

Figure 6 shows the numbers of breeding reindeer by reindeer husbandry year (1 June–31 May). The greatest permitted number of breeding reindeer in 2011–2020 is 203,700 animals. A breeding reindeer refers to an animal not slaughtered in the autumn.

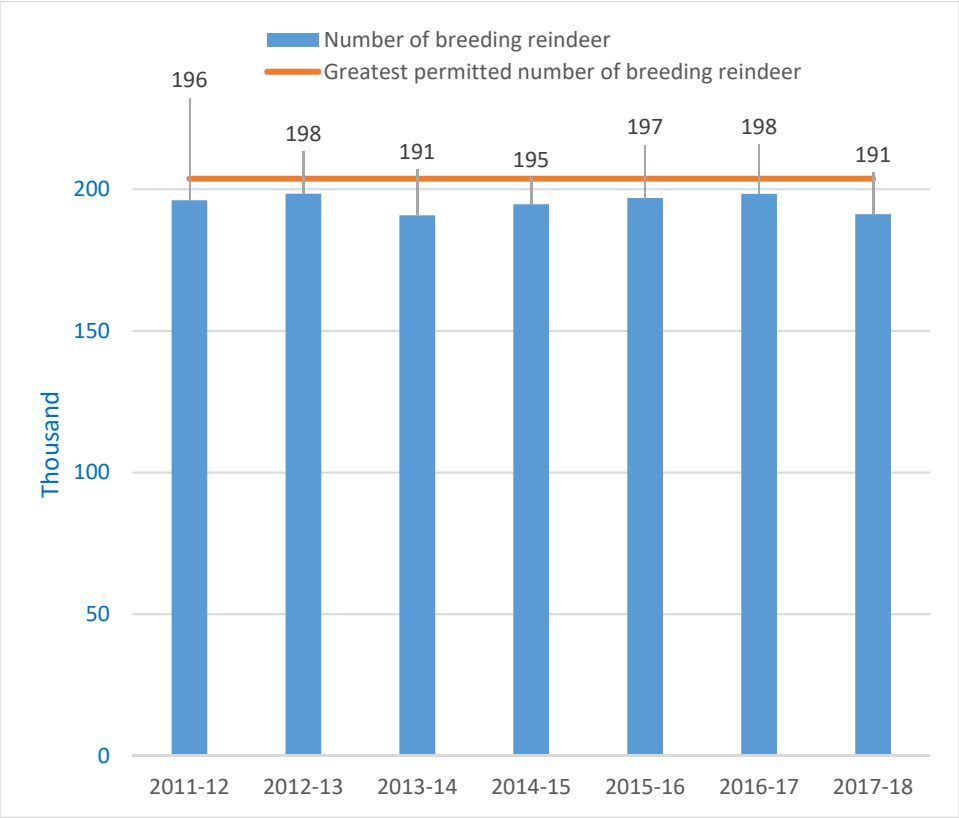


Figure 6. Numbers of breeding reindeer by reindeer husbandry year in 2011–2018 and the greatest permitted number of breeding reindeer. Source of breeding reindeer numbers: Reindeer Herders' Association/Matti Särkelä.

Observations and conclusions relating to Figure 6:

- Annual variations in reindeer numbers have been relatively minor in 2011–2018 and can thus not be considered a key factor affecting the number of reindeer collisions.

5.1.1 Temporal fluctuations in the numbers of collisions and alerts

Figure 7 shows the annual numbers of reindeer collisions and alerts in 2011–2018. Statistics on the numbers of reindeer alerts exist from 1 June 2016 on.

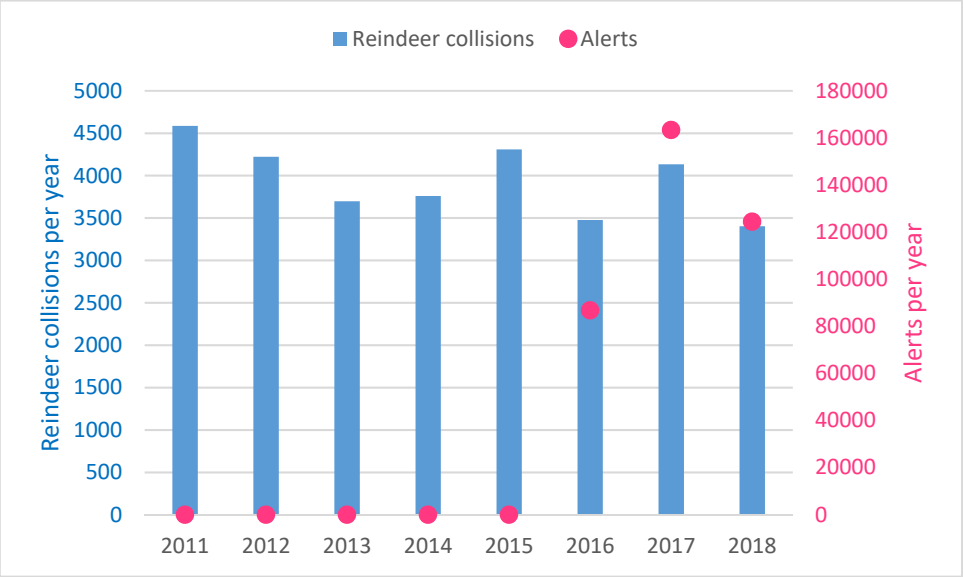


Figure 7. Annual numbers of reindeer collisions and alerts in 2011–2018. Alerts have been issued since June 2016.

Observations and conclusions relating to Figure 7:

- There have been clear yearly variations in the numbers of reindeer collisions, and no obvious trend in these figures can be discerned.
- The collision number was clearly lower in 2018 than in 2017.
- About one quarter less reindeer alerts were issued in 2018 than in 2017.

Figure 8 shows the monthly numbers of reindeer collisions in 2011–2018.

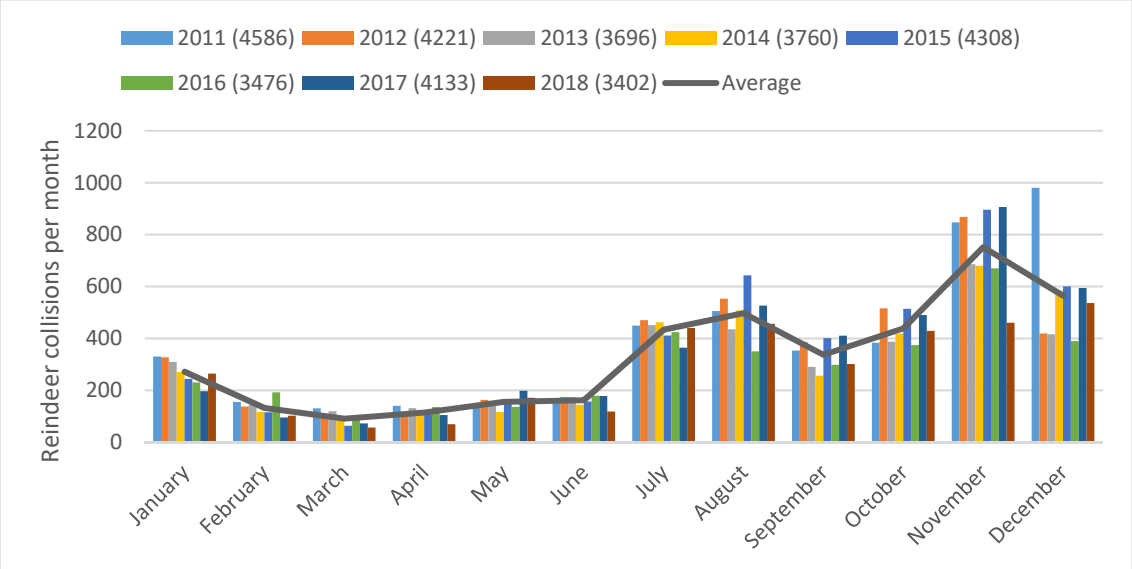


Figure 8. Monthly numbers of reindeer collisions in 2011–2018. The line indicates the average of collision numbers in each month in 2011–2018. The total number of collisions in the relevant year is shown in brackets.

Observations and conclusions relating to Figure 8:

- The greatest collision numbers occur late in the year at the time when the reindeer are on the move as they look for food and migrate to their winter pastures. The dark season makes the reindeer less easy to see. Between January and June, the collision numbers are clearly lower than at other times. In the early months of this period, the reindeer are mainly being fed out in the open or kept in pens.
- There has been major year-to-year variations in reindeer collision numbers, especially during the period between August and January.
    - The variations in collision numbers in early autumn are to some extent explained by yearly fluctuations in the food situation (fungus crop) and thus the need for the reindeer to move between pastures.
    - The variations in collision numbers towards the end of the year are to a great extent explained by the time at which the herders start feeding their animals in the forest and keeping them in pens, which varies from year to year according to meteorological conditions.
    - Other factors that affect the variations in collision numbers in winter include years with different snow and weather conditions (slippery roads, volume of snow, darkness, anti-skid treatments).

Tables 1–4 and Figures 9–12 show the variations in reindeer collisions and alerts by month and hour in 2017 and 2018. A colour scale has been used to illustrate the collision and alert numbers, in which the cells containing the greatest values of each set are dark red, whereas the cells with the lowest values are dark green. In the remaining cells, a gliding scale of red, yellow and green tones is used.

Figures 9–12 also show the relative distribution of traffic volumes determined based on the 43 Transport Measurement System (TMS) points located in the reindeer husbandry area. Five TMS points from which continuous data was not available for 2017 and 2018 were excluded from the analysis. The monthly distributions of the traffic volumes are based on measurement data covering the entire year, and the hourly distributions are based on the hourly variations in traffic volumes in weeks 41/2017 and 41/2018.

The collision numbers of the first hour of the day, or 00–01, also include collisions whose time was not known. No conclusions can thus be made based on the collision numbers of this hour.

*Table 1. Monthly and hourly numbers of **reindeer collisions in 2017**. A consistent colour scale has been used to illustrate the collision numbers in years 2017 and 2018, or Tables 1 and 2.*

Reindeer collisions 2017	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
January	12	3	2	0	5	4	9	5	9	3	5	12	19	10	6	12	9	16	16	17	5	5	9	3	**196**
February	9	0	2	2	0	1	6	4	4	6	3	3	5	7	5	5	3	6	7	11	0	3	0	3	**95**
March	4	0	1	1	0	3	4	3	1	6	5	1	5	2	6	4	3	3	7	4	4	2	2	1	**72**
April	3	2	1	2	1	3	2	4	3	4	6	5	9	10	8	7	5	4	10	0	4	4	4	3	**104**
May	16	0	4	0	2	7	13	14	13	12	13	11	16	2	9	7	12	6	7	5	6	13	4	6	**198**
June	7	1	2	0	4	5	5	5	14	9	10	7	14	10	15	8	6	13	9	6	8	7	9	4	**178**
July	16	3	3	2	2	8	5	11	15	14	17	16	21	16	25	25	24	26	35	16	28	20	13	3	**364**
August	16	4	3	0	3	5	15	17	23	24	31	31	46	27	34	38	37	34	28	32	33	20	18	7	**526**
September	14	2	4	2	1	4	20	16	26	24	23	16	30	20	16	32	36	27	32	16	22	19	6	2	**410**
October	15	2	2	3	1	3	5	20	38	20	29	23	39	23	29	34	35	43	49	37	14	9	7	10	**490**
November	27	9	4	9	3	10	17	29	53	39	55	46	54	30	34	61	121	91	66	27	39	45	24	13	**906**
December	22	5	7	6	7	13	14	15	29	26	23	24	34	23	32	54	70	54	39	29	24	20	11	13	**594**
	161	**31**	**35**	**27**	**29**	**66**	**115**	**143**	**228**	**187**	**220**	**195**	**292**	**180**	**219**	**287**	**361**	**323**	**305**	**200**	**187**	**167**	**107**	**68**	4133

*Table 2. Monthly and hourly numbers of **reindeer collisions in 2018**.*

Reindeer collisions 2018	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
January	15	2	4	3	3	4	9	10	16	10	11	11	23	12	9	22	23	22	13	10	7	14	5	6	**264**
February	4	1	1	2	1	1	1	6	8	6	4	3	5	7	3	8	7	11	8	4	5	4	1	1	**102**
March	3	2	0	1	0	1	3	3	2	0	2	0	4	1	3	2	3	2	5	3	3	7	4	2	**56**
April	7	1	1	1	0	2	3	4	0	3	2	0	4	5	3	0	5	2	6	4	2	4	5	5	**69**
May	14	5	3	0	2	0	9	9	9	7	10	4	10	8	9	7	10	7	19	8	7	3	6	5	**171**
June	7	1	0	0	1	2	6	6	5	1	3	7	7	9	4	3	14	11	6	7	5	2	7	4	**118**
July	17	10	4	1	3	2	13	12	15	31	23	15	33	19	20	28	25	23	27	24	35	33	16	11	**440**
August	21	2	9	1	8	8	14	18	22	22	26	22	28	19	21	16	31	32	30	31	28	30	10	7	**456**
September	12	0	0	0	2	8	10	19	11	17	21	16	21	20	16	19	22	14	15	18	21	13	5	1	**301**
October	14	4	5	4	4	3	12	23	17	23	32	19	37	22	23	29	31	26	35	29	18	7	6	3	**426**
November	20	3	1	1	3	3	10	6	26	29	38	23	25	26	27	43	69	25	21	8	15	11	9	4	**446**
December	17	2	7	3	4	2	5	21	24	28	23	19	16	26	36	44	59	39	18	24	27	25	25	10	**504**
	151	**33**	**35**	**17**	**31**	**36**	**95**	**137**	**155**	**177**	**195**	**139**	**213**	**174**	**174**	**221**	**299**	**214**	**203**	**170**	**173**	**153**	**99**	**59**	3353

*Table 3. Monthly and hourly numbers of **reindeer alerts in 2017**. A consistent colour scale has been used to illustrate the alert numbers in years 2017 and 2018, or Tables 3 and 4. A red tone is used to indicate a great number of alerts in this Table to facilitate comparisons with the tables describing the collision numbers.*

Alerts 2017	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
January	29	34	33	32	37	37	41	80	96	178	233	254	242	241	257	242	165	96	77	48	69	48	36	51	**2656**
February	9	14	19	14	12	17	23	96	118	143	150	110	86	110	117	135	178	87	68	25	46	28	12	19	**1636**
March	15	5	13	5	9	15	38	99	92	76	63	46	76	80	95	96	99	78	73	40	32	27	21	24	**1217**
April	35	21	21	13	16	45	81	148	108	109	82	98	116	188	145	173	135	113	125	91	99	124	72	48	**2206**
May	301	187	222	247	410	540	818	1413	1126	1328	1115	1063	1175	1347	1253	1470	1246	938	875	769	610	563	520	499	**20035**
June	294	188	188	234	234	384	600	801	902	1016	970	923	1048	1064	1061	1069	1024	926	702	615	526	421	479	401	**16070**
July	137	113	92	173	197	364	565	767	966	1078	934	972	972	1068	1100	1088	1140	998	826	782	657	495	353	232	**16069**
August	67	55	59	96	237	593	794	1323	1342	1486	1486	1546	1644	2056	2027	2325	2062	1703	1559	1140	776	467	227	124	**25194**
September	97	113	63	54	73	203	830	1888	1715	1382	1419	1418	1750	2058	1815	2115	1708	1504	1348	935	356	100	71	89	**23104**
October	165	141	104	112	115	129	218	1054	2087	2085	1797	1552	1509	2002	1916	2223	1867	1492	890	314	141	128	167	218	**22426**
November	317	218	178	190	206	289	295	837	1826	2335	2396	2343	2197	2552	2608	2418	1251	609	368	300	356	430	412	340	**25271**
December	144	77	82	69	94	113	116	195	228	422	758	817	773	941	746	556	280	186	165	148	142	134	128	144	**7458**
	1610	**1166**	**1074**	**1239**	**1640**	**2729**	**4419**	**8701**	**10606**	**11638**	**11403**	**11142**	**11588**	**13707**	**13140**	**13910**	**11155**	**8730**	**7076**	**5207**	**3810**	**2965**	**2498**	**2189**	163342

*Table 4. Monthly and hourly numbers of **reindeer alerts in 2018**.*

Alerts 2018	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
January	65	23	32	15	21	32	31	39	76	122	146	184	168	230	220	215	93	58	55	57	44	39	49	39	**2053**
February	24	12	9	11	6	24	5	39	73	86	72	65	48	59	79	80	88	55	29	22	20	13	20	19	**958**
March	5	1	6	4	11	15	17	43	38	28	17	32	22	23	22	43	33	50	29	17	10	8	9	11	**494**
April	21	18	11	31	39	61	78	149	125	112	80	105	126	133	127	168	110	96	94	77	74	66	60	46	**2007**
May	125	73	60	158	202	277	489	734	865	823	746	720	820	1041	1018	1048	853	769	666	631	496	396	317	238	**13565**
June	92	65	52	78	85	96	182	284	394	380	399	394	392	451	479	510	493	417	382	342	257	205	161	124	**6714**
July	243	176	162	191	272	382	616	939	1085	1179	900	1019	915	883	919	1058	1244	1197	1131	1321	1106	844	542	346	**18670**
August	87	79	81	128	285	551	923	1319	1577	1700	1610	1659	1522	1954	2003	2374	2249	1862	1725	1477	910	555	260	131	**27021**
September	67	46	44	16	44	165	465	965	931	791	720	792	890	1045	1028	1126	985	893	699	539	217	44	30	45	**12587**
October	133	84	60	72	92	46	135	760	1613	1748	1235	988	1145	1288	1500	1638	1513	1308	707	272	93	92	117	167	**16806**
November	132	93	91	106	164	129	134	431	1213	1595	1606	1465	1359	1569	1668	1783	782	286	189	187	254	307	233	180	**15956**
December	98	73	42	57	73	47	80	144	290	560	812	806	743	838	885	630	302	272	157	182	144	130	112	113	**7590**
	1092	**743**	**650**	**867**	**1294**	**1825**	**3155**	**5846**	**8280**	**9124**	**8343**	**8229**	**8150**	**9514**	**9948**	**10673**	**8745**	**7263**	**5863**	**5124**	**3625**	**2699**	**1910**	**1459**	**124421**

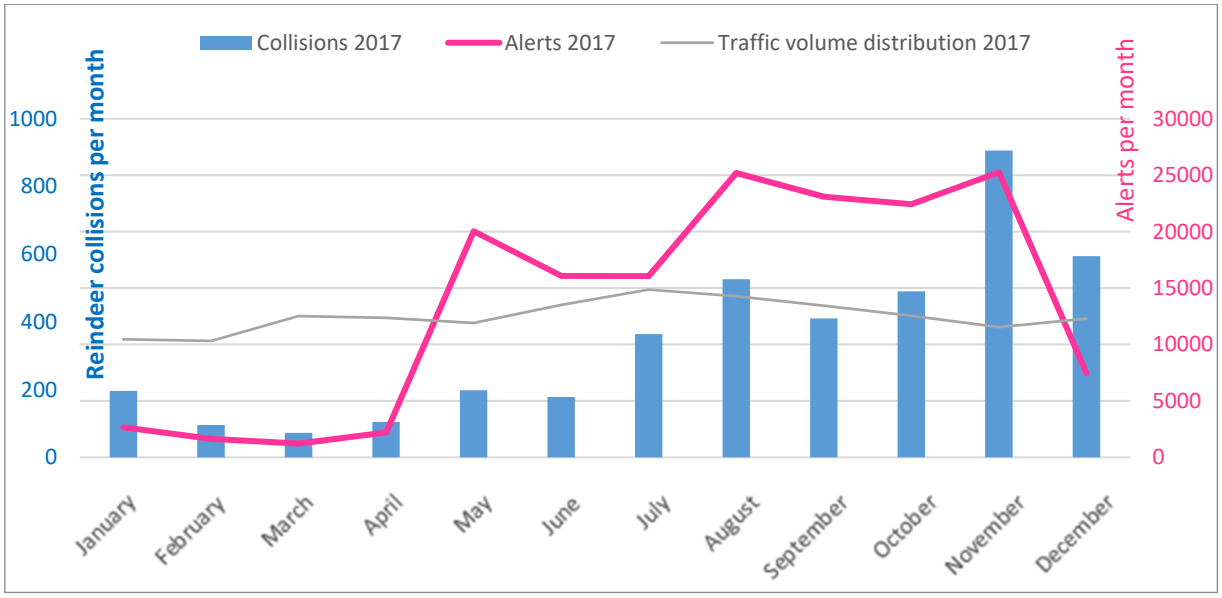


Figure 9. Relative monthly distribution of reindeer collisions and alerts in 2017 (the line describing variations in traffic volumes has been scaled to the vertical axis).

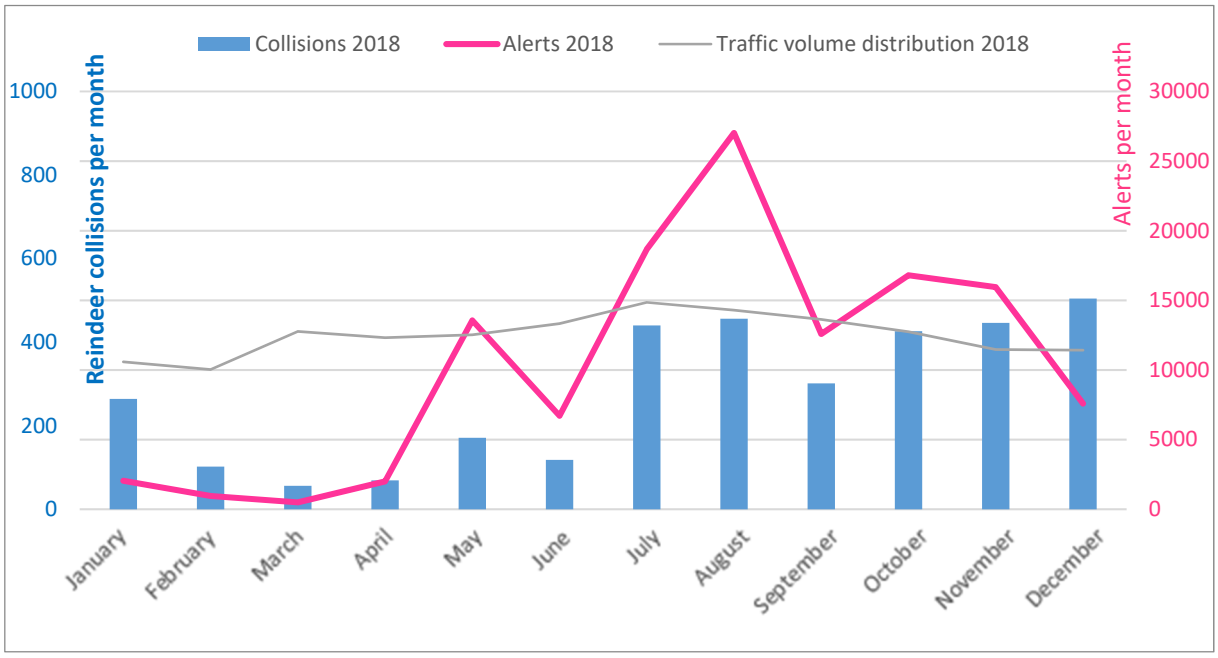


Figure 10. Relative monthly distribution of reindeer collisions and alerts in 2018 (the line describing variations in traffic volumes has been scaled to the vertical axis).

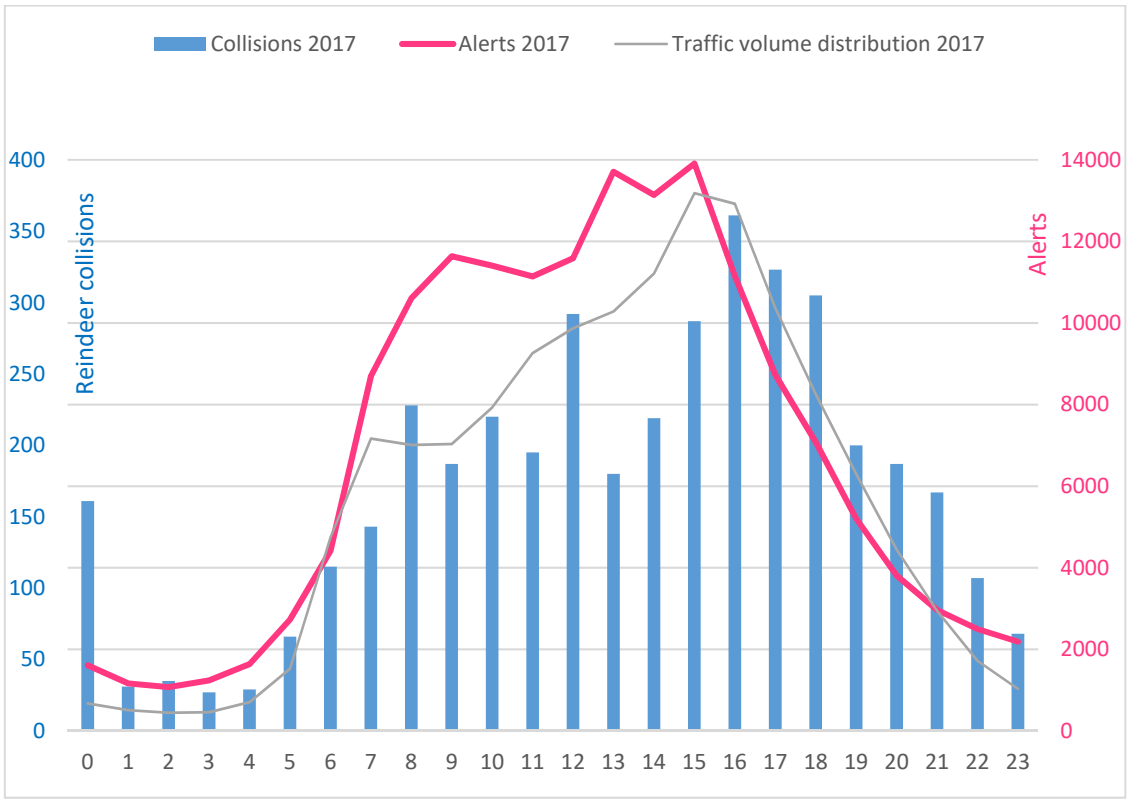


Figure 11. Relative hourly distribution of reindeer collisions and alerts in 2017 (the line describing fluctuations in traffic volumes has been scaled to the vertical axis).

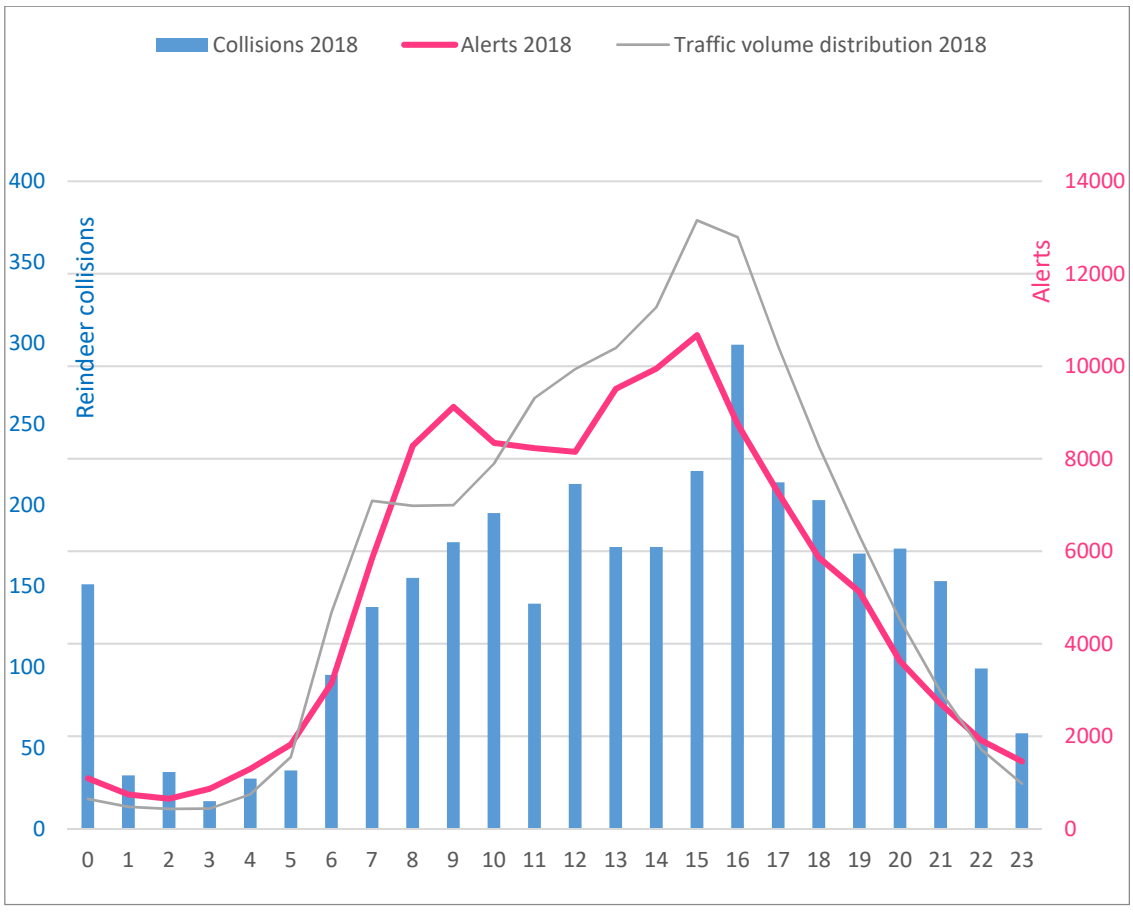


Figure 12. Relative hourly distribution of reindeer collisions and alerts in 2018 (the line describing fluctuations in traffic volumes has been scaled to the vertical axis).

Observations and conclusions relating to Tables 1–4 and Figures 9–12:

- A clear collision peak can be observed in November 2017, whereas in 2018, the collision numbers are more evenly distributed over the last months of the year. The difference between the total collision numbers in 2017 and 2018 is to a great extent explained by lower numbers in October–December 2018.
    - In 2017, thermal winter in the reindeer husbandry area began between 17 and 20 October. In 2018, thermal winter began on 19–23 October, or nearly at the same time as in 2017, in Lapland but a whole month later in the southern part of the reindeer husbandry area in North Ostrobothnia and Kainuu (18 November). Thermal winter begins as the average daily temperature drops permanently below zero. (Finnish Meteorological Institute 2019).
- The number of reindeer alerts issued in 2018 was about one quarter less than in 2017. There are major differences between the monthly distributions of reindeer alerts between the years.
    - In 2017, more or less an equal number of alerts was given in each month between August and November.
    - In 2018, there was an obvious peak in the alert numbers in August.
    - The greatest number of collisions in proportion to alerts was recorded in December and January.
- The traffic volumes in the reindeer husbandry area are the greatest in the middle of the summer in July and the lowest in January–February. The traffic volumes are more than 40% greater in July than in January and February. No clear interdependence can be observed between the traffic volume and the monthly distribution of collisions.
- The hourly variations in collisions, alerts and traffic volumes in 2017 and 2018 are quite similar.
    - The collision numbers to a great extent follow the traffic volume distribution. The greatest number of collisions occurs between 16.00 and 17.00. During the lightest hours of the day in the early afternoon, the number of collisions in proportion to the traffic volume is lower than in the morning or later in the afternoon. On the other hand, more collisions in proportion to the traffic volume occur late in the evening and at night.
    - The greatest numbers of alerts are given between 8.00 and 17.00. The alert numbers are the highest between 15.00 and 16.00, as are the traffic volumes. The alert numbers, along with the traffic volume, start declining more rapidly than the collision numbers after 16.00.
    - The peak in the hourly distribution of collisions at midnight is due to the fact that all collisions whose time of occurrence is not known are placed in this class.

Conclusions and recommendations relating to the Porokello alert system

- Based on the numbers of collisions and alerts, more persons giving warnings would be needed in December and January as well as in the afternoons and evenings after 16.00.

Figure 13 shows the total numbers of reindeer collisions and alerts by day of the week in 2017–2018 as well as the traffic volume distribution determined on the basis of data from TMS points for 2017–2018. Figure 14 shows the hourly distribution of reindeer collisions on different days of the week.

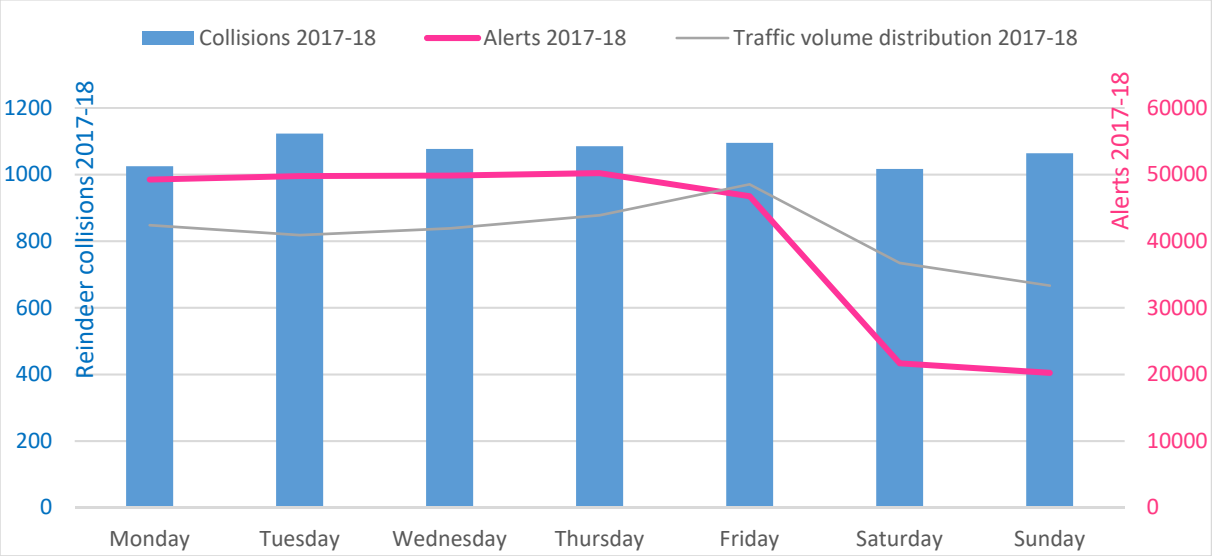


Figure 13. Relative distribution of reindeer collisions and alerts in 2017–2018 by day of the week (the line describing variations in traffic volumes has been scaled to the vertical axis).

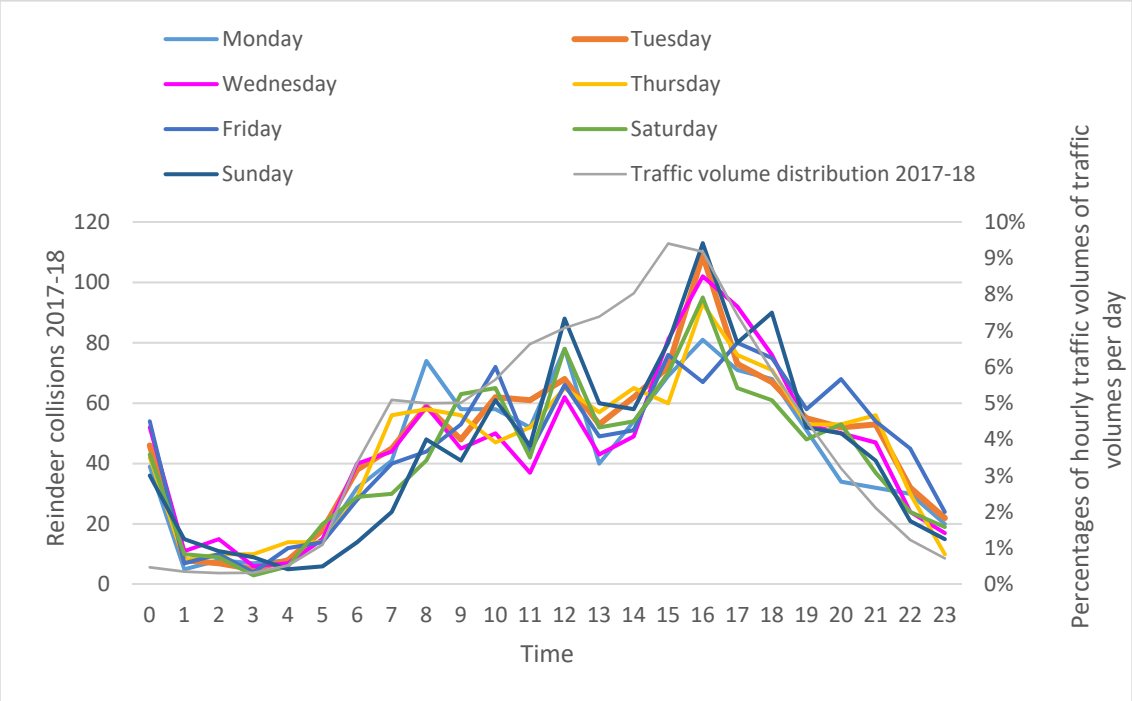


Figure 14. Hourly numbers of reindeer collisions and traffic volume distribution on different days of the week in 2017–2018.

Observations and conclusions relating to Figures 13 and 14:

- The numbers of reindeer collisions are in the same order of magnitude on different days of the week. The greatest number of collisions have occurred on Tuesdays.
- The daily alert numbers vary little from Monday till Thursday. The alert numbers are approx. 7% lower than on the first four days of the week on Fridays, 56% on Saturdays and 59% on Sundays.
- Traffic volumes are at their greatest on Fridays, whereas the weekend volumes are clearly lower than weekday volumes.
- In proportion to the alert numbers and traffic volumes, the number of reindeer collision has been clearly higher at weekends than on weekdays.
- The hourly distribution of reindeer collisions is more or less the same on weekdays and at weekends. The collision numbers of the first hour of the day, or 00.00–01.00, also include collisions whose time is not known.

Conclusions and recommendations relating to the Porokello alert system

- The low number of reindeer alerts at the weekend presumably is one of the factors contributing to the higher reindeer collision risk on those days.
- More persons giving warnings would be needed on the roads at the weekend.

Figures 15–17 show the average daily numbers of those who use the Porokello app, those who give warnings using the Varottaja app, and persons using the Porokello Pro alert phone by month, day of the week, and day from the beginning of May 2018 till the end of December 2018.

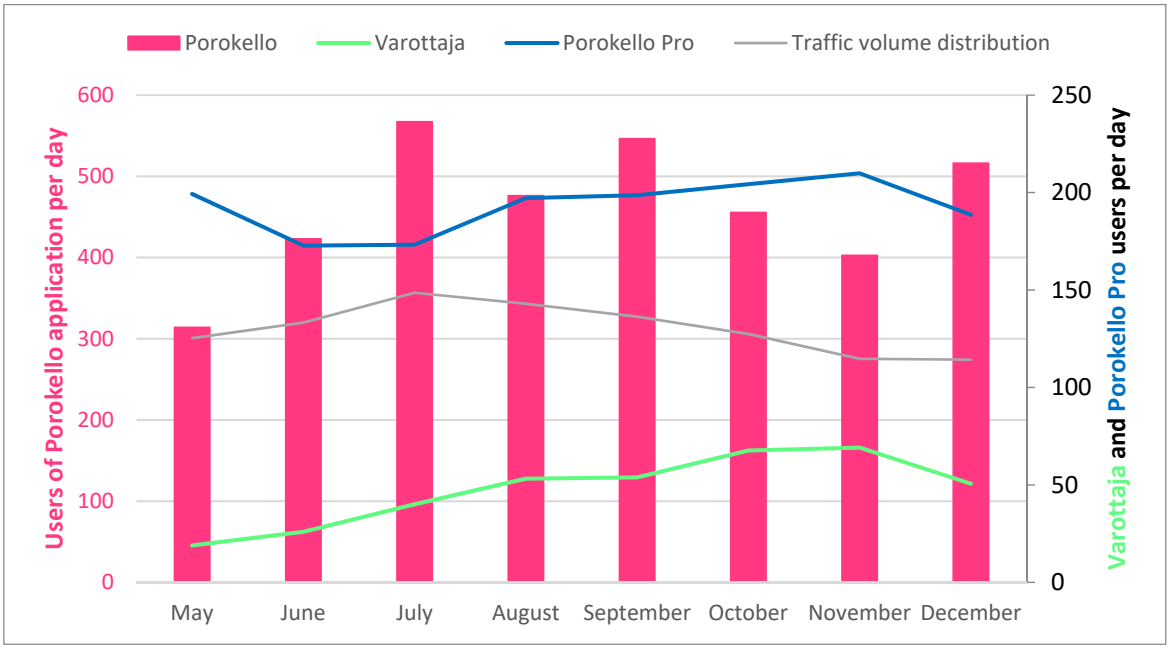


Figure 15. Average daily numbers of those using the Porokello app, those giving warnings using the Varottaja app, and users of Porokello Pro alert phone by month in May–December 2018. The relative distribution of the traffic volume over different months in 2018 has been scaled to the horizontal axis.

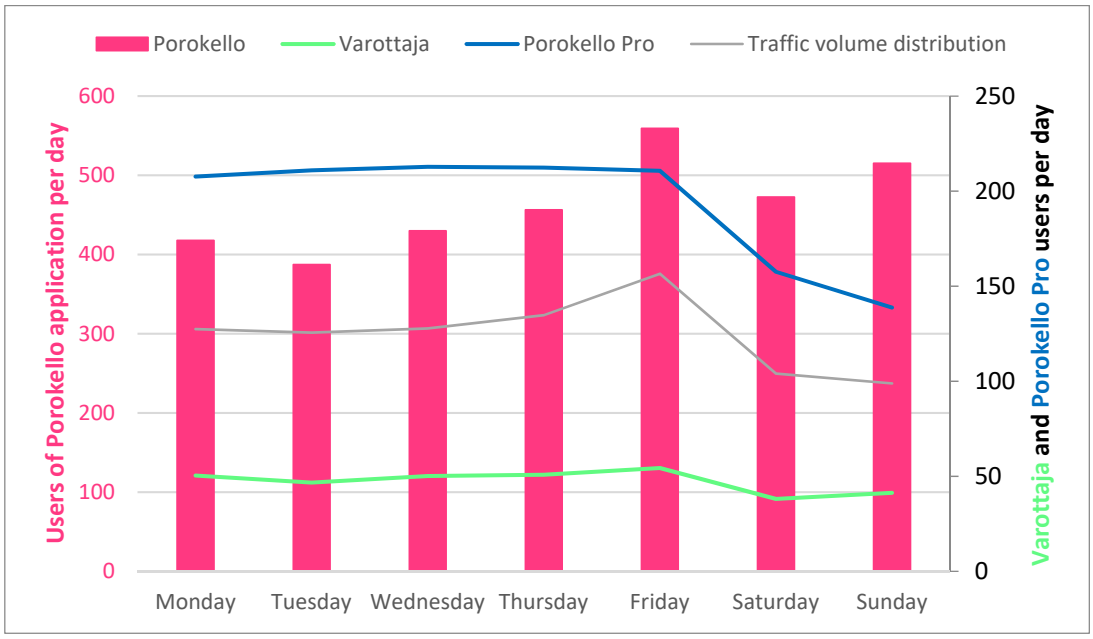


Figure 16. Average numbers of those using the Porokello app, those giving warnings using the Varottaja app, and users of the Porokello Pro alert phone by day of the week in May–December 2018. The relative distribution of the traffic volume over different days of the week in 2018 has been scaled to the horizontal axis.

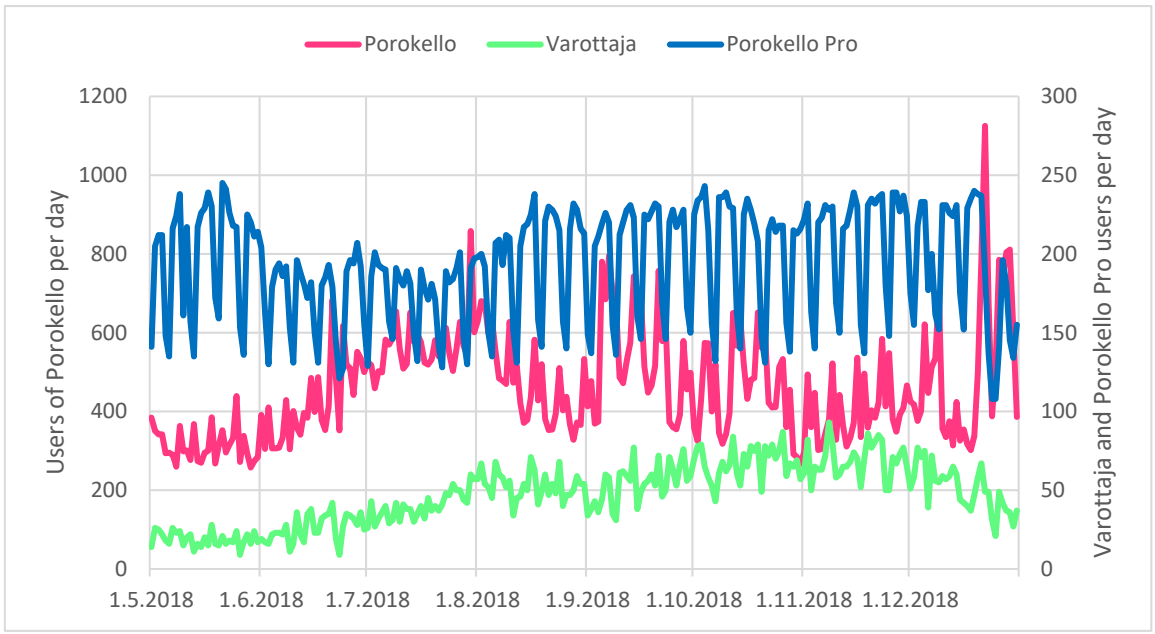


Figure 17. Daily numbers of those using the Porokello app, those giving warnings using the Varottaja app, and users of the Porokello Pro alert phone in May–December 2018.

Observations and conclusions relating to Figures 15–17:

- During the period under scrutiny, the Porokello app had the greatest number of users in July–September and in December. The app user numbers were relatively low in November, even if this is the month in which the greatest number of reindeer collisions usually occur. Examined by the day of the week, Porokello app had the most users towards the end of the week, or from Friday to Sunday. In Figure 17, we see individual peaks in app user numbers on days with busy tourist and holiday traffic, including Thu 21 June, Mon 30 July, weekends during the autumn colours period and Christmas traffic.
- The variations in Porokello app user numbers and traffic volumes are not directly comparable. In other words, the app users do not represent average road users.
- The monthly user numbers of the Varottaja app increased in May–November. While variations in user numbers on different days of the week were minor, slightly fewer users are active at weekends than on weekdays.
- User numbers of the Porokello Pro alert phones were lower in June–July and December than in the months between them, and clearly lower at weekends than on weekdays.

Conclusions and recommendations relating to the Porokello alert system

- Free-time traffic and private motoring appear to have a significant impact on Porokello app user numbers, as the app attracts the greatest number of users at weekends and on days with busy tourist and holiday traffic. On the other hand, fewer drivers using the Porokello Pro alert phone are on the roads at weekends and during the holiday seasons.

5.1.2 Geographical variation in collision and alert numbers

The distribution of collisions and alerts over different reindeer herders' cooperatives in 2017 and 2018 is illustrated in Tables 6 to 9. Figure 18 shows a map of the cooperatives, while the surface areas and greatest permitted numbers of breeding reindeer are given in Table 5.

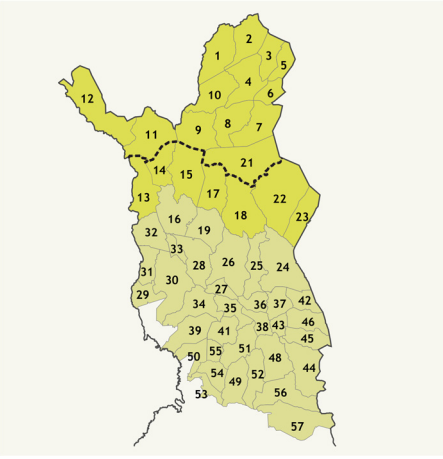


Figure 18. Reindeer herders' cooperatives on the map. Collision and alert numbers in different cooperatives in 2017 and 2018 are shown in Tables 6 to 9. Source: Reindeer Herders' Association.

Table 5. Surface areas of reindeer herders' cooperatives, greatest permitted number of breeding reindeer in 2011–2020, and the greatest permitted density of breeding reindeer based on this data, reindeer/km^2. The colour scale illustrates differences between the cooperatives. Source of surface areas and permitted breeding reindeer numbers: Reindeer Herders' Association.

	Surface area km2	Greatest permitted number of breeding reindeer	Greatest permitted density of breeding reindeer (reindeer / km2)		Surface area km2	Greatest permitted number of breeding reindeer	Greatest permitted density of breeding reindeer (reindeer / km2)
1 Paistunturi	2893	6300	2,18	29 Lohijärvi	1240	1400	1,13
2 Kaldoaivi	2478	5300	2,14	30 Palojärvi	3867	5000	1,29
3 Näätämö	1537	3600	2,34	31 Orajärvii	1251	1500	1,20
4 Muddusjärvi	2682	5200	1,94	32 Kolari	2007	2600	1,30
5 Vätsäri	1161	3000	2,58	33 Jääskö	587	1000	1,70
6 Paatsjoki	1053	1600	1,52	34 Narkaus	2432	2000	0,82
7 Ivalo	2889	6000	2,08	35 Niemelä	1268	1900	1,50
8 Hammastunturi	2520	5500	2,18	36 Timisjärvi	963	1900	1,97
9 Sallivaara	2906	7500	2,58	37 Tolva	1251	1900	1,52
10 Muotkatunturi	2596	6800	2,62	38 Posion Livo	966	1500	1,55
11 Näkkälä	3539	8300	2,35	39 Isosydänmaa	2325	2000	0,86
12 Käsivarsi	4852	10000	2,06	41 Kuukas	1424	1500	1,05
13 Muonio	2695	6000	2,23	42 Alakitka	1213	1600	1,32
14 Kyrö	1706	3500	2,05	43 Akanlahti	638	1000	1,57
15 Kuivasalmi	3474	6000	1,73	44 Hossa-Irni	3073	3000	0,98
16 Alakylä	2978	5300	1,78	45 Kallioluoma	1550	2300	1,48
17 Sattasniemi	2413	5300	2,20	46 Oivanki	1662	2400	1,44
18 Oraniemi	4085	6000	1,47	48 Taivalkoski	2456	2500	1,02
19 Syväjärvi	2315	5500	2,38	49 Pudasjärvi	2037	2200	1,08
21 Lappi	4396	8000	1,82	50 Oijärvi	1276	1300	1,02
22 Kemin-Sompio	5708	12000	2,10	51 Pudasjärven Livo	1894	2100	1,11
23 Pohjois-Salla	2137	4800	2,25	52 Pintamo	1819	2600	1,43
24 Salla	4402	5300	1,20	53 Kiiminki	825	800	0,97
25 Hirvasniemi	1928	2300	1,19	54 Kollaja	1171	1100	0,94
26 Pyhä-Kallio	3988	6500	1,63	55 Ikonen	631	500	0,79
27 Vanttaus	795	1200	1,51	56 Näljänkä	2840	2000	0,70
28 Poikajärvi	2529	4600	1,82	57 Halla	3500	2700	0,77

*Table 6. Numbers of **reindeer collisions** by cooperative **in 2017**. The same colour scale has been used to illustrate the collision numbers in 2017 and 2018, or in Tables 6 and 7.*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mon-Fri average	Sat.	Sun.	Total

2017	tammi	helmi	maalis	huhti	touko	kesä	heinä	elo	syys	loka	marras	joulu	ma-pe keskiarvo	la	su	Yht.
1 Paistunturi	2	0	0	0	0	3	0	6	0	0	0	4	3	1	1	15
2 Kaldoaivi	1	0	0	0	0	0	2	6	0	0	0	1	1	0	4	10
3 Näätämö	0	0	0	2	1	0	0	0	0	0	0	1	1	1	0	4
4 Muddusjärvi	3	4	3	7	10	0	5	4	0	0	8	11	8	3	12	55
5 Vätsäri	0	0	0	0	0	1	0	2	2	0	1	0	1	3	0	6
6 Paatsjoki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Ivalo	6	3	4	6	7	12	19	18	13	11	6	13	16	15	21	118
8 Hammastunturi	11	5	2	5	10	3	11	15	7	5	16	16	16	9	16	106
9 Sallivaara	0	2	2	2	2	1	2	4	0	1	3	4	3	4	4	23
10 Muotkatunturi	2	3	6	1	1	0	3	4	0	1	0	2	3	2	4	23
11 Näkkälä	16	12	16	6	11	7	10	13	7	7	21	15	20	21	19	141
12 Käsivarsi	7	4	4	15	22	6	4	4	9	4	30	4	17	13	13	113
13 Muonio	21	15	12	11	12	16	22	29	30	30	41	35	38	35	48	274
14 Kyrö	1	2	1	0	4	0	5	4	4	11	11	8	8	7	3	51
15 Kuivasalmi	6	3	2	3	3	2	1	9	5	2	14	11	9	4	11	61
16 Alakylä	0	1	0	2	3	4	6	12	19	27	31	0	16	8	15	105
17 Sattasniemi	5	2	1	1	4	0	2	1	5	1	26	22	12	7	5	70
18 Oraniemi	2	0	0	1	2	5	5	10	9	14	16	15	11	14	12	79
19 Syväjärvi	5	1	2	2	7	8	4	17	11	14	48	49	25	27	18	168
21 Lappi	4	6	0	0	1	5	6	10	12	11	10	7	11	8	9	72
22 Kemin-Sompio	2	1	0	2	0	2	3	2	7	6	10	9	7	7	2	44
23 Pohjois-Salla	3	0	0	2	1	0	0	2	0	4	4	5	2	3	6	21
24 Salla	4	0	2	1	12	5	12	14	16	18	21	18	17	23	14	123
25 Hirvasniemi	2	0	0	0	3	2	3	6	6	13	13	4	7	7	12	52
26 Pyhä-Kallio	21	5	7	6	4	7	10	15	9	16	45	30	26	25	22	175
27 Vanttaus	0	0	0	0	0	0	5	4	1	6	9	3	5	1	3	28
28 Poikajärvi	13	2	2	6	9	7	18	17	8	30	81	29	32	26	37	222
29 Lohijärvi	1	3	1	1	1	1	1	2	2	6	15	7	6	7	3	41
30 Palojärvi	3	3	0	2	4	1	8	14	10	15	59	34	23	11	26	153
31 Orajärvii	0	1	0	0	6	1	3	11	7	14	29	6	12	8	9	78
32 Kolari	0	0	1	1	2	1	2	10	13	13	18	6	10	11	8	67
33 Jääskö	0	0	0	1	1	2	1	3	1	4	5	1	3	2	3	19
34 Narkaus	2	1	0	0	2	0	10	13	5	7	10	10	8	10	8	60
35 Niemelä	0	0	0	1	1	0	6	5	3	7	4	2	4	3	5	29
36 Timisjärvi	1	0	0	0	0	1	6	7	4	3	5	7	5	4	6	34
37 Tolva	2	1	0	1	6	8	12	21	12	9	15	15	14	17	16	102
38 Posion Livo	2	0	0	0	1	0	6	4	11	9	9	7	7	7	7	49
39 Isosydänmaa	1	0	0	0	0	0	3	3	7	4	16	6	6	6	3	40
41 Kuukas	2	0	0	0	0	3	8	19	5	9	9	5	10	7	5	60
42 Alakitka	0	3	0	0	3	7	9	13	9	4	5	8	9	9	8	61
43 Akanlahti	0	0	0	0	0	1	6	8	6	3	5	5	5	4	5	34
44 Hossa-Irni	11	2	0	2	5	7	15	13	8	7	24	16	16	12	16	110
45 Kallioluoma	2	1	0	0	1	5	14	26	7	11	17	9	14	11	11	93
46 Oivanki	4	0	0	0	6	25	22	33	22	21	23	19	23	32	26	175
48 Taivalkoski	1	0	0	0	0	5	11	12	5	9	25	9	13	7	7	77
49 Pudasjärvi	3	0	0	0	4	3	11	16	24	29	49	32	23	25	31	171
50 Oijärvi	1	0	0	0	0	0	1	2	3	6	8	1	2	4	6	22
51 Pudasjärven Livo	1	0	0	2	1	2	9	4	5	10	15	6	7	10	10	55
52 Pintamo	2	0	0	1	4	2	20	23	15	13	30	24	16	23	29	134
53 Kiiminki	0	0	1	0	1	2	3	7	11	11	8	7	7	7	8	51
54 Kollaja	2	0	0	3	5	1	4	11	16	17	10	3	9	14	11	72
55 Ikonen	0	0	0	0	0	1	0	0	0	2	3	5	2	2	1	11
56 Näljänkä	2	2	0	4	7	1	6	3	6	8	13	6	8	11	8	58
57 Halla	16	7	3	4	8	2	9	15	13	7	12	22	17	14	17	118
	196	95	72	104	198	178	364	526	410	490	906	594	2977	552	604	4133

*Table 7. Numbers of **reindeer collisions** by cooperative **in 2018**.*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mon-Fri average	Sat.	Sun.	Total

2018	tammi	helmi	maalis	huhti	touko	kesä	heinä	elo	syys	loka	marras	joulu	ma-pe keskiarvo	la	su	Yht.
1 Paistunturi	0	0	1	0	3	1	1	0	0	1	0	0	1	0	0	**7**
2 Kaldoaivi	0	2	0	2	0	0	2	0	2	1	1	3	2	2	1	**13**
3 Näätämö	1	1	0	1	1	0	1	0	0	0	0	1	1	2	0	**6**
4 Muddusjärvi	15	11	3	3	4	1	6	5	2	8	5	17	12	9	9	**80**
5 Vätsäri	0	0	0	0	0	1	4	2	1	1	3	0	2	0	4	**12**
6 Paatsjoki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
7 Ivalo	12	6	2	0	1	5	21	11	3	2	7	14	11	16	11	**84**
8 Hammastunturi	13	6	5	5	8	5	9	4	5	5	0	6	10	14	9	**71**
9 Sallivaara	2	1	2	0	1	1	1	1	0	0	1	3	2	1	3	**13**
10 Muotkatunturi	1	2	1	2	3	0	1	2	1	0	2	0	2	0	3	**15**
11 Näkkälä	12	12	6	7	11	10	12	8	2	6	14	16	17	16	17	**116**
12 Käsivarsi	18	7	4	5	14	8	7	12	4	11	12	9	18	9	11	**111**
13 Muonio	24	11	8	6	10	6	27	32	18	30	34	32	33	30	42	**238**
14 Kyrö	5	0	2	3	2	1	6	8	8	7	7	9	8	11	7	**58**
15 Kuivasalmi	5	5	4	2	1	4	7	8	9	3	10	10	10	10	9	**68**
16 Alakylä	0	1	0	2	1	0	10	16	20	26	9	9	12	12	20	**94**
17 Sattasniemi	8	1	1	0	3	1	0	2	3	5	5	7	6	2	5	**36**
18 Oraniemi	5	2	0	0	7	1	6	6	5	15	13	10	11	7	8	**70**
19 Syväjärvi	9	1	1	5	4	4	2	7	10	12	16	12	13	8	8	**83**
21 Lappi	7	0	0	0	3	2	6	12	7	10	4	3	9	5	5	**54**
22 Kemin-Sompio	5	0	0	0	2	0	4	2	2	1	3	6	4	0	3	**25**
23 Pohjois-Salla	3	2	0	0	2	1	1	3	2	1	0	0	3	0	1	**15**
24 Salla	8	5	1	4	1	1	11	17	12	14	8	9	12	14	15	**91**
25 Hirvasniemi	4	1	1	1	2	3	5	8	5	13	9	3	8	11	4	**55**
26 Pyhä-Kallio	8	2	2	4	7	8	20	32	6	11	17	23	20	21	20	**140**
27 Vanttaus	0	0	0	0	0	2	8	7	2	3	5	6	5	5	3	**33**
28 Poikajärvi	21	6	2	5	13	2	32	12	9	24	25	23	27	24	16	**174**
29 Lohijärvi	2	2	1	0	0	0	2	0	1	4	6	8	4	4	4	**26**
30 Palojärvi	10	2	1	0	5	0	4	15	6	9	7	22	12	12	11	**81**
31 Orajärvii	1	0	0	0	4	0	5	7	5	9	12	10	8	10	5	**53**
32 Kolari	3	0	0	0	4	1	7	8	4	2	7	14	8	5	3	**50**
33 Jääskö	0	0	0	0	1	0	0	1	0	1	2	0	1	0	0	**5**
34 Narkaus	1	0	0	0	2	0	12	9	2	7	2	3	6	3	3	**38**
35 Niemelä	1	0	0	0	3	0	5	3	0	5	6	5	4	5	4	**28**
36 Timisjärvi	1	0	0	0	2	1	6	10	0	6	2	5	5	2	6	**33**
37 Tolva	3	2	2	0	2	5	17	13	8	16	7	9	13	6	14	**84**
38 Posion Livo	5	1	0	0	1	3	3	4	2	6	6	5	4	9	6	**36**
39 Isosydänmaa	1	0	0	0	1	0	1	2	2	8	6	9	5	5	1	**30**
41 Kuukas	1	0	0	0	1	2	13	11	7	5	9	4	7	8	8	**53**
42 Alakitka	5	1	0	0	3	4	18	8	4	9	10	2	8	11	13	**64**
43 Akanlahti	2	0	0	0	1	2	8	2	4	4	8	2	5	4	6	**33**
44 Hossa-Irni	12	2	2	0	1	4	4	21	8	8	10	24	13	18	11	**96**
45 Kallioluoma	1	1	0	0	4	2	16	11	9	5	12	11	10	12	8	**72**
46 Oivanki	10	0	0	1	6	6	32	38	21	28	23	15	26	26	23	**180**
48 Taivalkoski	1	0	0	2	2	5	11	13	9	9	8	27	13	10	13	**87**
49 Pudasjärvi	4	1	0	3	6	1	6	13	26	26	25	30	19	27	18	**141**
50 Oijärvi	1	1	0	0	1	1	1	1	0	5	5	8	3	6	1	**24**
51 Pudasjärven Livo	0	1	1	0	2	0	10	2	4	7	12	2	5	5	9	**41**
52 Pintamo	2	1	0	2	3	1	23	15	14	7	16	21	12	21	22	**105**
53 Kiiminki	3	1	1	0	1	2	8	6	5	5	7	10	7	5	11	**49**
54 Kollaja	0	0	0	1	6	3	1	7	11	11	9	8	8	10	9	**57**
55 Ikonen	0	0	0	0	0	0	1	0	1	3	1	1	1	0	2	**7**
56 Näljänkä	2	0	0	1	4	2	6	10	8	5	5	4	8	3	5	**47**
57 Halla	6	1	2	2	1	5	10	9	2	6	13	14	10	9	10	**71**
	264	**102**	**56**	**69**	**171**	**118**	**440**	**456**	**301**	**426**	**446**	**504**	**2428**	**465**	**460**	**3353**

*Table 8. Numbers of **reindeer alerts** by cooperative **in 2017**. The same colour scale has been used to illustrate the alert numbers in 2017 and 2018, or in Tables 8 and 9. A red tone is used to indicate a great number of alerts to facilitate comparisons with the table describing collision numbers.*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mon-Fri average	Sat.	Sun.	Total

2017	tammi	helmi	maalis	huhti	touko	kesä	heinä	elo	syys	loka	marras	joulu	ma-pe keskiarvo	la	su	Yht.
1 Paistunturi	75	134	54	26	57	39	27	53	16	22	28	52	102	36	36	**583**
2 Kaldoaivi	16	12	12	20	74	64	35	89	33	20	44	13	71	33	42	**432**
3 Näätämö	43	122	34	45	80	19	10	6	11	0	9	44	63	67	42	**423**
4 Muddusjärvi	138	138	75	166	519	250	175	163	99	61	191	274	364	219	211	**2249**
5 Vätsäri	1	4	8	1	8	14	17	24	22	19	8	1	21	17	7	**127**
6 Paatsjoki	0	0	0	4	0	0	0	0	0	0	0	0	1	0	0	**4**
7 Ivalo	161	110	51	146	532	671	868	929	728	217	69	65	733	465	416	**4547**
8 Hammastunturi	116	57	56	137	489	313	863	660	501	174	305	156	616	368	377	**3827**
9 Sallivaara	8	1	3	2	1	13	17	1	5	7	4	1	11	1	6	**63**
10 Muotkatunturi	23	44	48	22	23	25	32	37	29	9	12	4	53	26	16	**308**
11 Näkkälä	296	86	55	92	248	113	135	193	104	169	302	124	307	203	181	**1917**
12 Käsivarsi	43	21	25	164	727	312	76	169	172	80	145	37	316	214	176	**1971**
13 Muonio	114	83	98	126	1299	763	776	1995	1249	830	718	434	1464	564	600	**8485**
14 Kyrö	31	15	3	4	345	222	128	281	299	246	268	45	305	195	168	**1887**
15 Kuivasalmi	22	11	6	4	159	351	122	343	378	175	154	67	296	172	141	**1792**
16 Alakylä	28	27	24	82	1139	684	481	1197	1403	1168	504	114	1099	731	624	**6851**
17 Sattasniemi	110	50	36	60	323	244	191	162	137	223	790	434	477	176	198	**2760**
18 Oraniemi	25	12	11	46	323	270	217	365	312	341	352	145	426	155	135	**2419**
19 Syväjärvi	69	30	49	92	917	720	610	961	876	819	1970	646	1356	469	510	**7759**
21 Lappi	69	59	17	19	739	954	298	869	612	186	106	58	650	377	358	**3986**
22 Kemin-Sompio	20	9	6	9	14	24	26	65	11	17	110	66	66	28	18	**377**
23 Pohjois-Salla	48	15	19	14	55	17	16	96	60	44	161	123	123	32	19	**668**
24 Salla	37	16	23	46	537	322	353	807	628	614	531	202	739	244	179	**4116**
25 Hirvasniemi	13	5	9	4	315	290	202	253	314	343	221	22	339	168	126	**1991**
26 Pyhä-Kallio	80	40	61	152	1778	1252	782	898	667	601	817	457	1341	539	340	**7585**
27 Vanttaus	10	14	13	8	58	53	139	175	225	197	256	19	210	69	50	**1167**
28 Poikajärvi	141	43	23	79	2098	1287	1926	1859	1451	2463	4584	815	2886	1257	1080	**16769**
29 Lohijärvi	37	32	26	45	259	81	83	152	491	539	557	94	442	110	75	**2396**
30 Palojärvi	215	136	115	164	713	475	470	867	1038	1491	1994	452	1427	569	427	**8130**
31 Orajärvii	74	43	18	26	580	373	243	401	475	1182	1162	87	838	267	207	**4664**
32 Kolari	28	27	7	21	242	236	216	441	474	466	472	71	471	152	193	**2701**
33 Jääskö	7	8	16	3	36	38	43	87	98	204	398	93	182	65	56	**1031**
34 Narkaus	25	19	14	18	174	134	269	293	179	168	169	58	242	153	156	**1520**
35 Niemelä	21	6	2	4	101	132	186	225	214	177	246	72	252	83	45	**1386**
36 Timisjärvi	17	2	2	8	108	293	297	344	295	368	279	45	367	156	66	**2058**
37 Tolva	12	2	4	19	234	576	500	622	563	582	323	67	631	212	136	**3504**
38 Posion Livo	40	10	7	7	174	67	184	381	415	471	238	74	377	134	47	**2068**
39 Isosydänmaa	37	3	7	10	139	107	89	77	93	164	129	23	154	48	61	**878**
41 Kuukas	15	2	6	1	110	175	153	314	348	545	211	44	330	144	128	**1924**
42 Alakitka	10	4	1	1	205	327	309	372	255	196	137	32	329	109	93	**1849**
43 Akanlahti	6	1	0	0	33	80	82	178	137	128	135	40	152	35	26	**820**
44 Hossa-Irni	56	10	10	47	308	161	290	334	282	284	523	190	446	117	146	**2495**
45 Kallioluoma	16	11	0	0	121	261	434	749	381	337	251	90	455	190	188	**2651**
46 Oivanki	48	23	22	14	522	712	1039	1795	1172	706	352	166	1160	431	339	**6571**
48 Taivalkoski	13	4	2	15	487	660	586	827	880	820	894	305	967	427	232	**5493**
49 Pudasjärvi	29	22	15	37	456	448	338	912	1529	1600	1875	383	1339	533	418	**7644**
50 Oijärvi	2	10	4	5	14	17	7	18	55	47	14	2	31	17	21	**195**
51 Pudasjärven Livo	11	3	2	21	156	178	231	310	279	438	671	167	421	194	168	**2467**
52 Pintamo	22	4	14	13	341	364	798	1119	1523	1312	1143	297	1241	428	318	**6950**
53 Kiiminki	7	0	3	8	159	35	84	208	243	183	38	13	172	62	61	**981**
54 Kollaja	23	12	4	30	1011	544	122	809	949	680	173	37	773	258	270	**4394**
55 Ikonen	0	1	1	1	2	3	22	20	18	47	44	8	27	17	15	**167**
56 Näljänkä	21	8	14	20	230	99	190	181	122	109	98	41	208	51	43	**1133**
57 Halla	127	75	82	98	263	208	282	508	254	137	86	89	362	252	149	**2209**
	2656	**1636**	**1217**	**2206**	**20035**	**16070**	**16069**	**25194**	**23104**	**22426**	**25271**	**7458**	**141163**	**12039**	**10140**	**163342**

*Table 9. Numbers of **reindeer alerts** by cooperative **in 2018**.*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mon-Fri average	Sat.	Sun.	Total

2018	tammi	helmi	maalis	huhti	touko	kesä	heinä	elo	syys	loka	marras	joulu	ma-pe keskiarvo	la	su	Yht.
1 Paistunturi	74	95	44	11	21	20	28	32	18	16	6	13	67	19	24	**378**
2 Kaldoaivi	28	13	8	22	29	23	15	83	13	25	14	17	47	32	23	**290**
3 Näätämö	63	93	25	0	9	4	15	4	1	0	2	10	36	26	21	**226**
4 Muddusjärvi	158	93	31	43	200	61	136	207	43	56	68	235	215	140	117	**1331**
5 Vätsäri	2	5	1	1	5	8	25	17	7	11	10	12	14	30	5	**104**
6 Paatsjoki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
7 Ivalo	133	81	19	33	355	171	827	661	89	146	77	76	391	343	372	**2668**
8 Hammastunturi	136	30	20	28	161	98	508	274	45	29	57	117	241	168	132	**1503**
9 Sallivaara	1	2	1	1	2	7	0	5	2	2	1	75	11	22	24	**99**
10 Muotkatunturi	36	17	8	7	21	10	7	20	11	0	2	21	24	21	18	**160**
11 Näkkälä	45	30	8	22	129	33	85	182	86	72	279	337	210	143	117	**1308**
12 Käsivarsi	39	13	16	27	449	100	81	200	131	96	33	81	199	127	146	**1266**
13 Muonio	188	110	36	102	1028	353	1086	2265	838	725	1122	556	1429	573	692	**8409**
14 Kyrö	10	1	5	3	174	31	218	350	255	77	72	33	196	101	148	**1229**
15 Kuivasalmi	28	10	2	3	169	75	178	628	292	88	126	80	287	103	142	**1679**
16 Alakylä	21	21	14	38	539	207	693	1390	772	965	493	214	868	475	552	**5367**
17 Sattasniemi	76	33	18	22	286	96	199	230	152	158	135	177	266	122	129	**1582**
18 Oraniemi	30	4	7	13	225	105	320	551	255	305	358	320	416	231	180	**2493**
19 Syväjärvi	106	21	1	116	621	283	776	1118	291	517	390	274	772	309	344	**4514**
21 Lappi	36	10	14	1	815	161	386	654	247	120	87	32	401	233	323	**2563**
22 Kemin-Sompio	6	2	1	2	17	12	28	43	12	21	75	93	52	37	17	**312**
23 Pohjois-Salla	32	7	15	25	50	31	18	12	3	3	5	15	41	7	6	**216**
24 Salla	27	3	1	43	204	175	505	689	258	363	342	102	423	275	320	**2712**
25 Hirvasniemi	6	1	0	16	148	51	230	434	205	413	173	33	265	224	162	**1710**
26 Pyhä-Kallio	78	14	9	129	736	311	880	1623	324	645	587	224	904	527	515	**5560**
27 Vanttaus	10	1	1	0	24	51	87	98	95	236	202	14	130	76	92	**819**
28 Poikajärvi	195	33	22	353	1215	717	2208	2163	619	1795	1458	580	1948	762	858	**11358**
29 Lohijärvi	34	15	12	43	85	49	30	60	129	155	238	120	176	50	38	**970**
30 Palojärvi	154	72	41	106	455	254	497	834	599	1230	1074	684	997	547	467	**6000**
31 Orajärvii	19	32	12	56	369	105	174	498	173	477	479	166	448	171	149	**2560**
32 Kolari	22	7	19	44	168	89	195	653	140	280	234	86	335	112	151	**1937**
33 Jääskö	15	15	19	6	39	27	95	195	78	141	170	299	194	59	68	**1099**
34 Narkaus	12	8	6	18	94	64	285	161	108	111	171	42	178	83	105	**1080**
35 Niemelä	5	0	0	2	40	49	127	160	89	75	167	67	129	50	86	**781**
36 Timisjärvi	8	0	0	3	54	60	219	291	102	146	226	29	189	91	102	**1138**
37 Tolva	6	2	1	13	142	338	709	699	346	428	442	108	542	246	279	**3234**
38 Posion Livo	5	3	3	32	46	110	277	317	244	400	311	54	334	74	60	**1802**
39 Isosydänmaa	4	2	1	12	77	31	43	97	83	149	276	100	150	59	66	**875**
41 Kuukas	2	2	14	18	177	77	278	514	269	238	350	67	330	153	201	**2006**
42 Alakitka	0	1	0	11	222	107	405	365	188	212	211	23	303	129	103	**1745**
43 Akanlahti	3	0	0	2	40	55	98	221	96	167	242	59	173	51	67	**983**
44 Hossa-Irni	35	5	6	82	195	186	337	232	200	218	277	182	321	161	188	**1955**
45 Kallioluoma	13	1	2	2	256	170	533	672	261	160	200	50	378	224	206	**2320**
46 Oivanki	33	9	3	83	847	416	1696	1856	675	638	494	137	1199	457	435	**6887**
48 Taivalkoski	7	2	1	95	411	306	689	800	569	645	702	195	763	302	304	**4422**
49 Pudasjärvi	35	4	4	76	593	294	440	1340	760	1468	1351	484	1183	464	471	**6849**
50 Oijärvi	1	2	5	15	17	5	9	17	42	40	19	13	30	19	14	**185**
51 Pudasjärven Livo	14	9	2	41	235	124	281	583	331	531	620	289	560	122	136	**3060**
52 Pintamo	19	3	2	21	304	291	908	804	946	832	802	304	912	334	344	**5236**
53 Kiiminki	1	1	1	4	40	23	47	136	90	198	116	40	118	44	62	**697**
54 Kollaja	3	0	3	92	721	53	128	878	753	661	204	67	609	216	301	**3563**
55 Ikonen	0	0	0	0	3	2	8	5	8	23	30	2	14	2	9	**81**
56 Näljänkä	3	2	2	45	157	56	204	214	126	113	223	78	215	85	63	**1223**
57 Halla	36	18	8	24	146	179	419	486	118	186	153	104	308	195	142	**1877**
	2053	**958**	**494**	**2007**	**13565**	**6714**	**18670**	**27021**	**12587**	**16806**	**15956**	**7590**	**104699**	**9626**	**10096**	**124421**

Observations and conclusions relating to Tables 6 to 9:

- The greatest reindeer collision numbers in 2017–2018 were recorded in the reindeer herders' cooperatives of Muonio (cooperative no 13), Poikajärvi (no 28), Oivanki (no 46), Pyhä-Kallio (no 26) and Pudasjärvi (no 49).
- The number of alerts in 2017–2018, on the other hand, was clearly the greatest in the cooperative of Poikajärvi, followed by Muonio, Pudasjärvi, Palojärvi (no 30) and Oivanki.
- As a rule, a great number of alerts is given in the cooperatives where many reindeer collisions occur.
- The greatest permitted density of breeding reindeer in the cooperative (reindeer/km2) does not appear to be comparable to the numbers of collisions and alerts, as the cooperatives with the greatest numbers of collisions and alerts include those with both high and low reindeer densities. This is understandable, as there are major differences between the reindeer herding environments, density of the road network and traffic volumes in different cooperatives.

Conclusions and recommendations relating to the Porokello alert system

- The highest numbers of alerts are given in those very cooperatives where high numbers of collisions occur and in which the need for the alerts thus is the greatest.

Figure 19 shows the numbers of reindeer collisions and alerts in 2017–2018 in the southern part of the reindeer husbandry area, where the reindeer are fed in the forest or kept in pens over winter, and in the northern part, where the reindeer are usually not kept in pens over winter. The indicative boundary between areas in which reindeer are and are not kept in pens over winter loosely follows the boundary of the designated reindeer herding area shown in Figure 19.

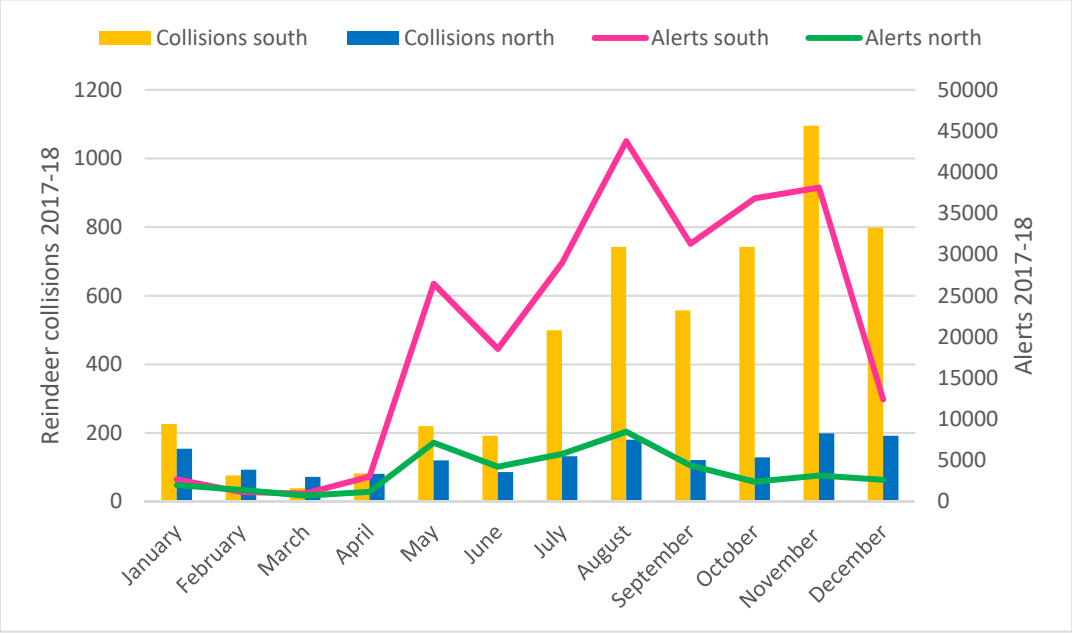


Figure 19. Reindeer collisions and alerts in 2017–2018 in the southern part of the reindeer husbandry area where the reindeer are fed in the forest or kept in pens over winter, and in the northern part, where the reindeer are not kept in pens over winter as a rule. The figure only shows the collisions whose locations are known.

Observations and conclusions relating to Figure 19:

- Clearly the greatest part of reindeer collisions occur and alerts are given in the area where the reindeer are fed in the forest/kept in pens (to the south of the indicative boundary), which is geographically larger and has clearly higher traffic volumes than the northern side.
- There are less variations in reindeer collisions and alerts at different times of the year on the northern than on the southern side of the indicative boundary below which the reindeer are fed in the forest/kept in pens. In the area where the reindeer are fed in the forest/kept in pens, the numbers of collisions and alerts are clearly lower during the period when the reindeer are kept in pens than during the period when they are moving around freely.

5.1.3 Analyses by road section

For the analyses by road section, 1,166 road sections (road numbers ≤ 9999) were divided into sub-sets based on different factors, and the following indicators were calculated for each sub-set:

- Rate of reindeer accidents in 2011–2015 and 2017–2018
- Absolute and relative change in the reindeer accident rate (from 2011–2015 to 2017–2018)
- Number or alerts and proportion of all alerts
- Average number of persons giving warnings
- Number of reindeer collisions in 2011–2015 and 2017–2018
- Proportion of reindeer collisions (2011–2015 + 2017–2018) of reindeer collisions on all road sections in the same period
- Proportion of the transport performance (2011–2015 + 2017–2018) of the performance on all road sections in the same period
- Total length of the road sections

15 road sections whose ATD for 2011–2015 was not known were excluded from the examination. The examination also includes road sections on which no reindeer collisions have taken place, where no persons giving warnings travelled, or where no reindeer alerts were given.

The correlation between the alerts, the driving routes of persons giving warnings and changes in accident rates were also studied by means of correlation analysis. The analysis looked at Pearson's linear correlation coefficient values between variables, which are commonly applied to similar data in statistical mathematics.

Alerts and persons giving warnings

The impacts that the number of persons giving warnings and the alert density (alerts/km) have on the reindeer collision rates of road sections were examined by ranking the road sections based on the indicator to be analysed and, based on this, forming six sub-sets, the first one of which contains the top 20% of the road sections by the indicator to be examined, the next set the following 20% and so on. The sixth sub-set contains road sections with no alerts or persons giving warnings.

Table 10. Numbers of persons giving warnings and alerts.

Caption	n	Average collision rate 11 - 15	Average collision rate 17-18	Change in collision rate	Change in collision rate (%)	Alerts	Share of alerts (%)	Persons giving warnings, avg. 17-18 *1)	Persons giving warnings, avg. 17-18 *2)	Collisions 11 - 15 yht.	Collisions 17-18 yht.	Share of collisions (%)	Share of performance (%)	Length of road section (km)
All road sections	1166	171,8	145,49	-26,27	-15 %	258850	100 %	5247	4558	17124	6220	100 %	100 %	7857
Number of persons giving warnings														
Largest 20 %	233	129,2	108,2	-21,08	-16 %	143078	55 %	18503	18171	6407	2323	37 %	50 %	1267
20 % - 40 %	233	219,0	197,3	-21,74	-10 %	73923	29 %	5071	5123	4904	1845	29 %	22 %	1583
40 % - 60 %	233	259,5	200,7	-58,82	-23 %	29436	11 %	1852	1846	2954	999	17 %	11 %	1800
60 % - 80 %	233	238,8	222,5	-16,36	-7 %	9143	4 %	686	687	1628	644	10 %	7 %	1662
Smallest 20 %	192	376,9	298,0	-78,85	-21 %	2389	1 %	174	181	972	331	6 %	3 %	1172
No persons giving warnings	42	37,2	26,6	-10,63	-29 %	881	0 %	0	0	259	78	1 %	7 %	373
Alerts / km														
Largest 20 %	233	246,3	218,7	-27,60	-11 %	194798	75 %	11016	12013	8980	3348	53 %	36 %	1636
20 % - 40 %	233	163,3	144,0	-19,25	-12 %	43970	17 %	6055	4904	3844	1443	23 %	24 %	1649
40 % - 60 %	233	146,9	118,3	-28,58	-19 %	14301	6 %	3500	2893	2011	710	12 %	14 %	1466
60 % - 80 %	233	131,3	90,7	-40,60	-31 %	5298	2 %	1928	1276	1911	581	11 %	15 %	1788
Smallest 20 %	117	59,6	48,1	-11,49	-19 %	483	0 %	1396	835	354	128	2 %	6 %	885
No alerts	117	4,5	5,1	0,56	12 %	0	0 %	6089	1881	25	12	0 %	6 %	434
**1) Arithmetic mean*														
**2) Mean weighted by length of road section*														

Accident density, accident rate and change in accident rate

In the examination of accident densities and accident rates (2011–2015), the road sections were ranked by their accident densities and rates and, on this basis, five sub-sets were formed, the first one of which contains the top 20% of the road sections, the next set the following 20% and so on. Road sections on which no accidents have occurred were classified as a separate sub-set.

To examine the change in the accident rate, the road sections on which the accident rate had gone up were divided into two sets based on their accident numbers, and the same procedure was followed with the road sections where the accident rate had gone down.

Observations and conclusions relating to Table 10:

- The number of persons giving warnings is the greatest on road sections with a high traffic performance and collision numbers but also a low accident rate both in 2011–2015 and 2017–2018.
- The greatest number of alerts in proportion to the length of the road section are given on roads with busy traffic and a high accident rate. On these road sections, however, the relative change 2011–2015 → 2017–2018 was smaller than average.
- The alerts mainly focus on certain parts of the road network, as 92% of the alerts are given for road sections accounting for 40% of the total number of road sections.

Table 11. Reindeer accident density in 2011–2015, reindeer accident rate in 2011–2015, and the change in reindeer accident rate per road section 2011–2015 → 2017–2018.

Caption	n	Average collision rate 11 - 15	Average collision rate 17 - 18	Change in collision rate	Change in collision rate (%)	Alerts	Share of alerts (%)	Persons giving warnings on average 17-18 *1)	Persons giving warnings on average 17-18 *2)	Collisions 11 - 15 in total	Collisions 17-18 in total	Share of collisions (%)	Share of performance (%)	Length of road sections (km)
All road sections	1166	171,8	145,49	-26,27	-15 %	258850	100 %	5247	4558	17124	6220	100 %	100 %	7857
Collision density 2011-15														
Highest 20 %	233	311,0	248,8	-62,20	-20 %	168260	65 %	9379	10134	10716	3616	61 %	34 %	1648
20 % - 40 %	233	176,1	142,6	-33,48	-19 %	51926	20 %	5028	4817	4007	1399	23 %	23 %	1789
40 % - 60 %	233	121,4	115,6	-5,90	-5 %	24879	10 %	2681	2407	1828	762	11 %	15 %	1793
60 % - 80 %	200	46,5	68,0	21,50	46 %	9940	4 %	2309	1974	574	354	4 %	12 %	1594
No accidents	267	0,0	13,5	13,47	-	3845	1 %	6272	2937	0	89	0 %	15 %	1034
Collision rate 2011-15														
Highest 20 %	233	636,6	437,4	-199,28	-31 %	77898	30 %	3057	3225	7719	2326	43 %	12 %	1874
20 % - 40 %	233	354,4	242,1	-112,28	-32 %	87682	34 %	4465	4913	4910	1846	29 %	18 %	1762
40 % - 60 %	233	179,5	143,0	-36,52	-20 %	58549	23 %	4714	4559	3048	1270	18 %	21 %	1788
60 % - 80 %	200	53,8	48,2	-5,68	-11 %	30876	12 %	7960	7091	1447	690	9 %	34 %	1400
No collisions	267	5,9	13,5	7,57	-	3845	1 %	6272	2937	0	89	0 %	15 %	1034
Change in collision rate 2011-15 ->17-18														
Coll. rate increased, highest 50 %	194	222,9	456,9	233,95	105 %	36195	14 %	2469	2433	1836	1526	14 %	8 %	1263
Coll. rate increased, lowest 50 %	193	114,6	146,4	31,76	28 %	75233	29 %	7655	7035	3030	1607	20 %	26 %	1525
Coll. rate decreased, lowest 50 %	284	130,6	93,6	-37,03	-28 %	80669	31 %	6488	6108	5132	1592	29 %	40 %	2174
Coll. rate decreased, highest 50 %	283	488,6	231,7	-256,93	-53 %	64777	25 %	2868	3015	7127	1497	37 %	15 %	2170
No collisions	212	0,0	0,0	0,00	-	1976	1 %	7109	3023	0	0	0 %	11 %	725
**1) Arithmetic mean*														
**2) Mean weighted by length of road section*														

Observations and conclusions relating to Table 11:

- The accident rates in 2017 to 2018 were more than 30% lower on road sections that had the worst accident rates from 2011 to 2015. A great number of alerts have been given on these road sections in proportion to the traffic volume.
    - The alerts are likely to be one factor in the positive development of safety.
- The road sections where the accident density is greatest, i.e. where most accidents have occurred, carry high volumes of traffic. Over one half (65%) of the alerts have been given for these road sections. The safety improvements on these road sections from the period 2011 to 2015 to the period 2017 to 2018 have been better than average.
    - The alerts are likely to be one factor in the positive development of safety.
- On road sections where the accident densities or accident rates were low from 2011 to 2015, accident densities and rates have decreased by less than average or have increased. Significantly fewer alerts have been given on these road sections than on those where the accident densities and rates are higher.

Road class, ADT and speed limit

For the analysis of road class, ADT (average daily traffic) and speed limits, the road sections were divided into sub-sets based on the aforementioned factors. All sub-sets were thus different in size.

Table 12. Analyses of road class, ADT and speed limit. The green cells indicate a statistically significant change in the accident rate of the relevant sub-set 2011–2015 → 2017–2018. Orange cells indicate a change that was not statistically significant.

Caption	n	Average collision rate 11 - 15	Average collision rate 17 - 18	Change in collision rate	Change in collision rate (%)	Alerts	Share of alerts (%)	Persons giving warnings on average 17-18 *1)	Persons giving warnings on average 17-18 *2)	Collisions 11 - 15 in total	Collisions 17-18 in total	Share of collisions (%)	Share of performance (%)	Length of road sections (km)	The most plausible change in collision rate Before - After	95% confidence interval for the change	
All road sections	1166	171,8	145,49	-26,27	-15 %	258850	100 %	5247	4558	17124	6220	100 %	100 %	7857	-15 %	-21 %	-10 %
Road class																	
Class I main road (road nr 1 - 39)	292	145,4	117,5	-27,93	-19 %	131933	51 %	13123	12193	7902	2757	46 %	55 %	1707	-19 %	-26 %	-11 %
Class II main road (road nr 40 - 99)	173	180,6	165,8	-14,85	-8 %	74655	29 %	7772	6810	3839	1498	23 %	21 %	1195	-8 %	-19 %	4 %
Regional road (road nr 100 - 999)	392	217,7	185,4	-32,23	-15 %	36620	14 %	1675	1669	3914	1356	23 %	18 %	2844	-15 %	-25 %	-3 %
Connecting road (road nr 1000 - 9999)	309	239,4	207,0	-32,40	-14 %	15642	6 %	921	1004	1470	608	9 %	6 %	2112	-14 %	-29 %	5 %
Average Daily Traffic																	
0 - 350	521	336,6	268,3	-68,27	-20 %	30955	12 %	899	970	3851	1341	22 %	12 %	3859	-20 %	-30 %	-9 %
351 - 1500	448	227,0	204,9	-22,13	-10 %	149212	58 %	4758	5145	9565	3638	57 %	42 %	3192	-10 %	-17 %	-2 %
over 1500	197	80,4	62,1	-18,34	-23 %	78683	30 %	17856	19400	3709	1241	21 %	46 %	807	-23 %	-35 %	-8 %
Speed limit																	
Under 60 km/h	55	8,3	7,7	-0,59	-7 %	1002	0 %	10727	9198	29	12	0 %	4 %	88	-5 %	-81 %	262 %
60 km/h	31	13,7	6,4	-7,29	-53 %	432	0 %	10358	10590	15	3	0 %	1 %	28	-54 %	-99 %	309 %
Mean between 60 - 80 km/h	273	150,2	129,3	-20,86	-14 %	22755	9 %	3947	2688	2388	909	14 %	16 %	1905	-14 %	-27 %	1 %
80 km/h	385	231,5	193,2	-38,28	-17 %	27793	11 %	1677	1285	2777	1013	16 %	12 %	2688	-17 %	-28 %	-3 %
Mean between 80 - 100 km/h	253	153,8	128,4	-25,41	-17 %	118823	46 %	9205	9080	6975	2503	41 %	46 %	1944	-17 %	-24 %	-8 %
100 km/h	168	226,0	198,0	-27,98	-12 %	88045	34 %	6874	7047	4940	1779	29 %	22 %	1205	-12 %	-24 %	-2 %
No information available	1	0,0	0,0	0,00	-	0	0 %	10	10	0	0	0 %	0 %	0			
**1) Arithmetic mean*																	
**2) Mean weighted by length of road section*																	

Observations and conclusions relating to Table 12:

Road class

- The greatest number of persons giving warnings drive, and alerts are given, on highways and regional roads. The accident rate or risk was higher in these road classes than on sub-regional and connecting roads.
- The average change in the accident rate (before/after) between 2011–2015 and 2017–2018 was -15%, and its 95% range was -20%…-10%; consequently, the change was statistically highly significant ($p<0.001$). This means that the change was with a high certainty (99.9% probability) genuine rather than random.
- Depending on road class, the changes in accident rates were between -8% and -19%; on highways and sub-regional roads, the change was statistically significant ($p<0.001$ and $p<0.01$).
- On regional roads and connecting roads, the change in the accident rate was not statistically significant.
- The 95% range in this and the following analyses was calculated by examining the credibility of the change using likelihood functions, presuming that the accidents follow a Poisson distribution.

ADT (Traffic volume)

- The accident rate, or risk, is low on the busiest roads (ADT over 1,500). While the highest number of persons giving warnings is found on the busier roads, the greatest part of the alerts are given in the ADT category 351–1,500 vehicles/day, in which the accident risk is clearly higher than on busier roads but still lower than on roads with a low traffic volume (ADT no more than 350 vehicles/day).
- By traffic volume class, the average changes in the accident rate were the most obvious on roads with very low traffic volumes (ADT no more than 350) and on the road network with busy traffic (ADT over 1,500 vehicles/day).
- The changes were statistically significant in all ADT categories examined ($p<0.01$).

Speed limits

- The greatest numbers of persons giving warnings are found, and the most alerts are given, on road sections where the speed limit is 100 km/h at least for some of the section.
- In speed limit areas of 80–100 km/h, the average change in accident rate was -17%, and the changes were statistically significant ($p<0.01$).
- On sections with lower speed limits, the changes varied between -5% … -54% but were not statistically significant.

Ratio analyses

Ratio analyses were carried out for three ratios related to the driving routes of persons giving warnings and to alerts: ”persons giving warnings/ADT”, ”alerts/transport performance” and ”collisions/alerts”. These analyses are based on data from 2017–2018. Each ratio was divided into five sub-sets in order of magnitude. Road sections with no persons giving warnings, alerts or collisions were placed in separate sub-sets.

Table 13. Ratios ”Persons giving warnings/ADT”, ”Alerts/Transport performance” and ”Collisions/Alerts””.

Caption	n	Average collision rate 11 - 15	Average collision rate 17 - 18	Change in collision rate	Change in collision rate (%)	Alerts	Share of alerts (%)	Persons giving warnings on average 17-18 *1)	Persons giving warnings on average 17-18 *2)	Collisions 11 - 15 in total	Collisions 17-18 in total	Share of collisions (%)	Share of performance (%)	Length of road sections (km)
All road sections	1166	171,8	145,49	-26,27	-15 %	258850	100 %	5247	4558	17124	6220	100 %	100 %	7857
Persons giving warnings / Average daily traffic ratio														
Highest 20 %	233	250,6	217,3	-33,31	-13 %	144947	56 %	10158	9799	6808	2486	40 %	27 %	1951
20 % - 40 %	233	198,9	166,3	-32,60	-16 %	63318	24 %	6816	5350	4330	1545	25 %	22 %	1661
40 % - 60 %	233	166,8	139,1	-27,73	-17 %	31549	12 %	4907	2839	2882	1036	17 %	17 %	1581
60 % - 80 %	233	109,8	95,5	-14,30	-13 %	15030	6 %	3274	2015	1807	681	11 %	17 %	1280
Lowest 20 %	192	103,1	87,6	-15,51	-15 %	3125	1 %	1336	735	1038	395	6 %	10 %	1012
No persons giving warnings (ratio 0)	42	37,2	26,6	-10,63	-29 %	881	0 %	0	0	259	78	1 %	7 %	373
Alerts / transport performance ratio														
Highest 20 %	233	361,3	319,8	-41,55	-12 %	157129	61 %	6427	6949	7220	2648	42 %	20 %	1741
20 % - 40 %	233	226,7	210,5	-16,16	-7 %	67391	26 %	4575	5031	4741	1850	28 %	21 %	1819
40 % - 60 %	233	184,3	141,6	-42,74	-23 %	23891	9 %	3758	3577	2916	965	17 %	16 %	1537
60 % - 80 %	233	101,3	82,7	-18,59	-18 %	9170	4 %	4485	3064	1766	628	10 %	18 %	1653
Lowest 20 %	117	22,8	13,2	-9,65	-42 %	1269	0 %	7874	4729	457	117	2 %	20 %	674
No alerts (ratio 0)	117	4,5	5,1	0,56	12 %	0	0 %	6089	1881	25	12	0 %	6 %	434
Collisions / alerts - ratio														
Highest 20 %	233	261,7	267,6	5,91	2 %	8079	3 %	1343	1077	2881	1291	18 %	11 %	1861
20 % - 40 %	233	236,3	228,3	-7,96	-3 %	38149	15 %	3839	3502	4315	1779	26 %	18 %	1793
40 % - 60 %	233	205,5	175,1	-30,40	-15 %	129255	50 %	8476	8341	6803	2441	40 %	33 %	1798
60 % - 80 %	100	185,0	125,5	-59,51	-32 %	76060	29 %	9092	9774	2468	697	14 %	13 %	808
No collisions (ratio 0)	250	34,2	0,0	-34,25	-100 %	7307	3 %	5255	3285	632	0	3 %	19 %	1163
No alerts (noncalculable)	117	4,5	5,1	0,56	12 %	0	0 %	6089	1881	25	12	0 %	6 %	434
**1) Arithmetic mean*														
**2) Mean weighted by length of road section*														

Observations and conclusions relating to Table 13:

Ratio "Persons giving warnings/ADT"

- The ratio describes the proportion of persons giving warnings in the traffic flow.
- The reindeer collision rates and the numbers of reindeer collisions and alerts are the greatest on the road sections with the most persons giving warnings in proportion to the traffic volume. The greatest number of alerts are also given for these road sections.
  - ➔ In other words, the greatest numbers of persons giving warnings in proportion to the traffic volume are found on precisely those road sections where the collision risk is high and there is a need for alerts.

Ratio "Alerts/Transport performance"

- The ratio describes the number of alerts given for a road section in proportion to the transport performance (vehicle-kilometres).
- The reindeer collision rates and the numbers of reindeer collisions and alerts are the highest on the road sections where the greatest number of alerts has been given in proportion to the transport performance.
  - ➔ The greatest number of alerts in proportion to the transport performance is given on road sections with the highest collision risk and greatest need for alerts.

Ratio "Collisions/Alerts"

- The ratio describes the number of collisions on a road section per alerts given.
- In sub-sets with a high ratio the collision risk, or the accident rate, is high and the number of persons giving warnings low. In these sub-sets, the accidents rates have increased, or only decreased marginally, between the periods 2011–2015 and 2017–2018.

Correlation analyses

Correlation analysis was used to investigate the link between the numbers of alerts, alert density (alerts/km), density of persons giving warnings (persons/ADT) and the indicator "alerts/transport performance" on different road sections and the changes in the reindeer accident rates on these sections from 2011–2015 to 2017–2018 by looking at Pearson's linear correlation coefficient values between the variables. The analyses did not find a link between changes in accident rates and the alert variables.

The findings were probably affected by the fact that the data does not contain information on the numbers of reindeers on the road or road margins, or crossing the roads, in 2011–2015 and 2017–2018. It is likely that the data contain several road sections with either considerably fewer or considerably more reindeer in 2017–2018 than in 2011–2015 on average. If a significantly higher number of reindeer were found on a road section, it is likely that much more accidents occurred on this section in 2017–2018 than in 2011–2015, whereas a great number of reindeer alerts was probably also issued on the same road section in 2017–2018. Similarly, if there were fewer reindeer on a road section than before, clearly fewer reindeer collisions took place there, and relatively few alerts were also given. Consequently, on road sections where reindeer numbers have changed significantly, an increase in the number of reindeer collisions would appear to be linked to an increase in the number of reindeer alerts. This would explain the findings in Table 13 (for example, the accident rates have decreased the most on sections with the lowest number of alerts/transport

performance). At the same time, this also explains why in a correlation analysis of the entire data set, the increase in warning numbers does not appear to be linked to a reduction in reindeer collision numbers, even if this were true for the road sections where the reindeer numbers have remained more or less at the same level in 2011–2018.

The analyses did not find a link between changes in accident rates and the alert variables. The probable reason for this is that changes in the numbers of reindeer moving on road sections could not be taken into account in the analysis.

Summary of road section analyses

The analyses of road sections indicate that the driving routes of persons giving warnings and the alerts given by them concentrate on roads with busy traffic and high accident density (collisions/km). The numbers of persons giving warnings and alerts given are much higher on the main road network than on the lower-grade road network, which is understandable as professional traffic mainly travels along the main roads.

The analyses show that the greatest number of alerts is given on road sections with a high accident rate, also on the lower-grade road network. The road sections with a high accident rate see the greatest number of reindeer collisions in proportion to the traffic volume, or the accident risk is the greatest. On road sections with a high collision risk where the number of persons giving warnings is low, the accident rates reduced between 2011–2015 and 2017–2018 less than average, or even increased.

On the basis of road section analyses and a correlation analysis, there is no direct link between the number of people giving warnings and the number of alerts on the one hand, and the changes in the number of reindeer collisions and the accident rate on the other. The probable reason for this is that changes in the numbers of reindeer moving on road sections could not be taken into account in the analysis.

Data on the number of road users only receiving alerts through the Porokello app on specific road sections was not available to the study. One possible explanation for the lack of correlation between the number of people giving warnings and the number of alerts on the one hand and the change in the accident rate in the statistical analysis on the other could be that the number of drivers receiving reindeer alerts accounts for a low proportion of all road users.

5.2 Map analyses

Hourly examination of collision and alert densities

For the road sections with the highest collision densities (collisions/km) by the hour of the day, see the maps in Figure 20. In this Figure, the 10% of road sections with the highest collision densities are shown in red (collision density > 0.287 collisions/km), with the following 10% shown in orange (collision densities between 0.146–0.287 collisions/km). The collision numbers of the first hour of the day, or 00–01, also include collisions whose time was not known. No conclusions can thus be made based on the collision numbers of this hour.

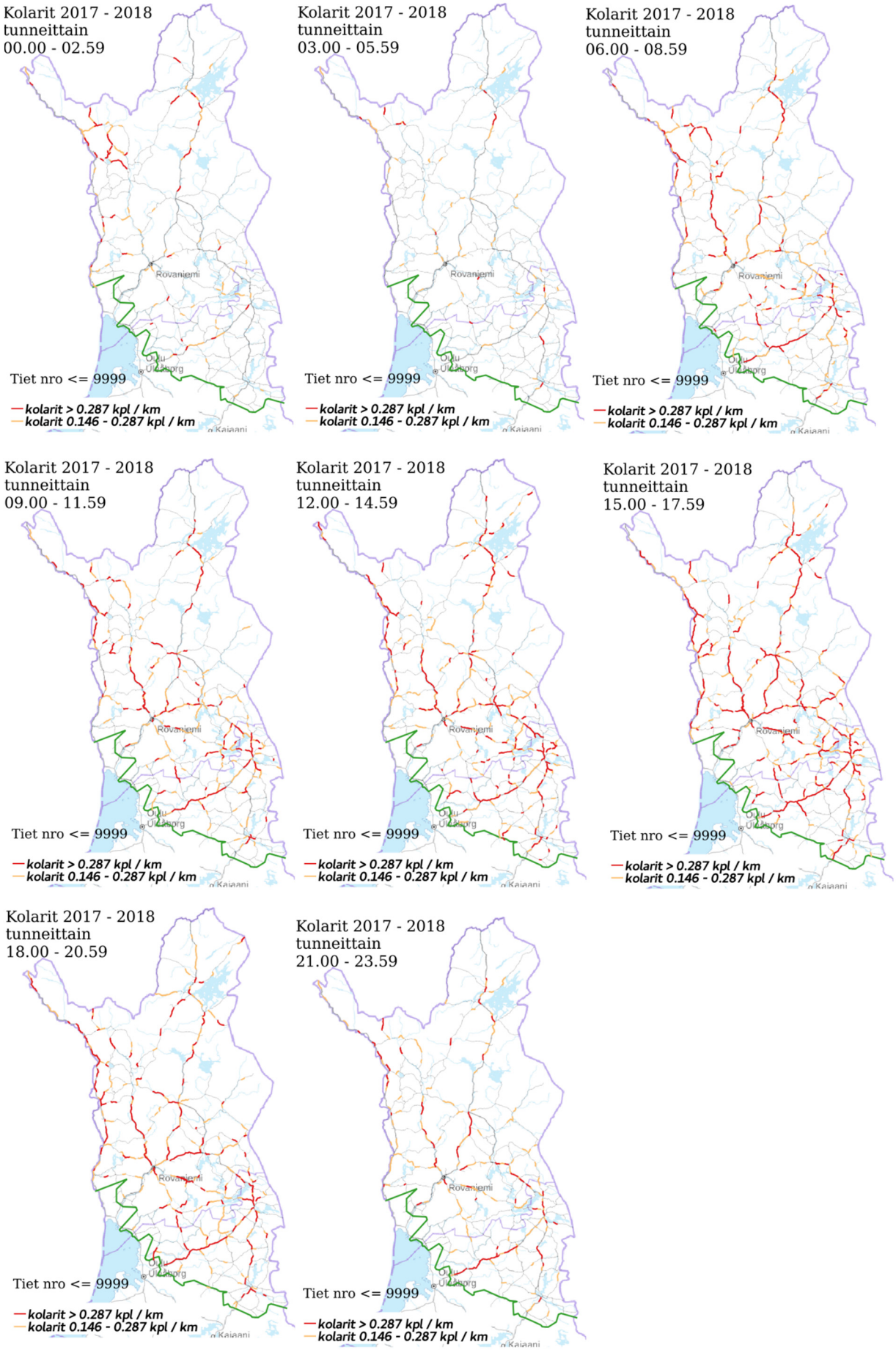


*Figure 20. The road sections with the highest **reindeer collision densities** in the reindeer husbandry area **by hour of the day** (collisions / km).*

On the maps describing night time, individual road sections with the highest collision densities can be identified in the northernmost parts of the reindeer husbandry area. The collision density on the main roads increases in the hours of morning, day and afternoon. The longest road sections with high collision densities are found on the following roads:

- Highway 4 around Inari and Ivalo
- Highway 20 between Oulu and Kuusamo
- Highway 21 north of Kolari
- Highway 79 Rovaniemi – Kittilä
- Highway 82 between Vikajärvi and Kemijärvi
- Sub-regional roads around Kuusamo.

For road sections with the highest alert densities (alerts/km) by the hour of the day, see the maps in Figure 21. In this Figure, the 10% of road sections with the highest alert densities are shown in red (alert density > 10.17 alerts/km) and the following 10% are shown in orange (alert densities between 4.77–10.287 alerts/km).

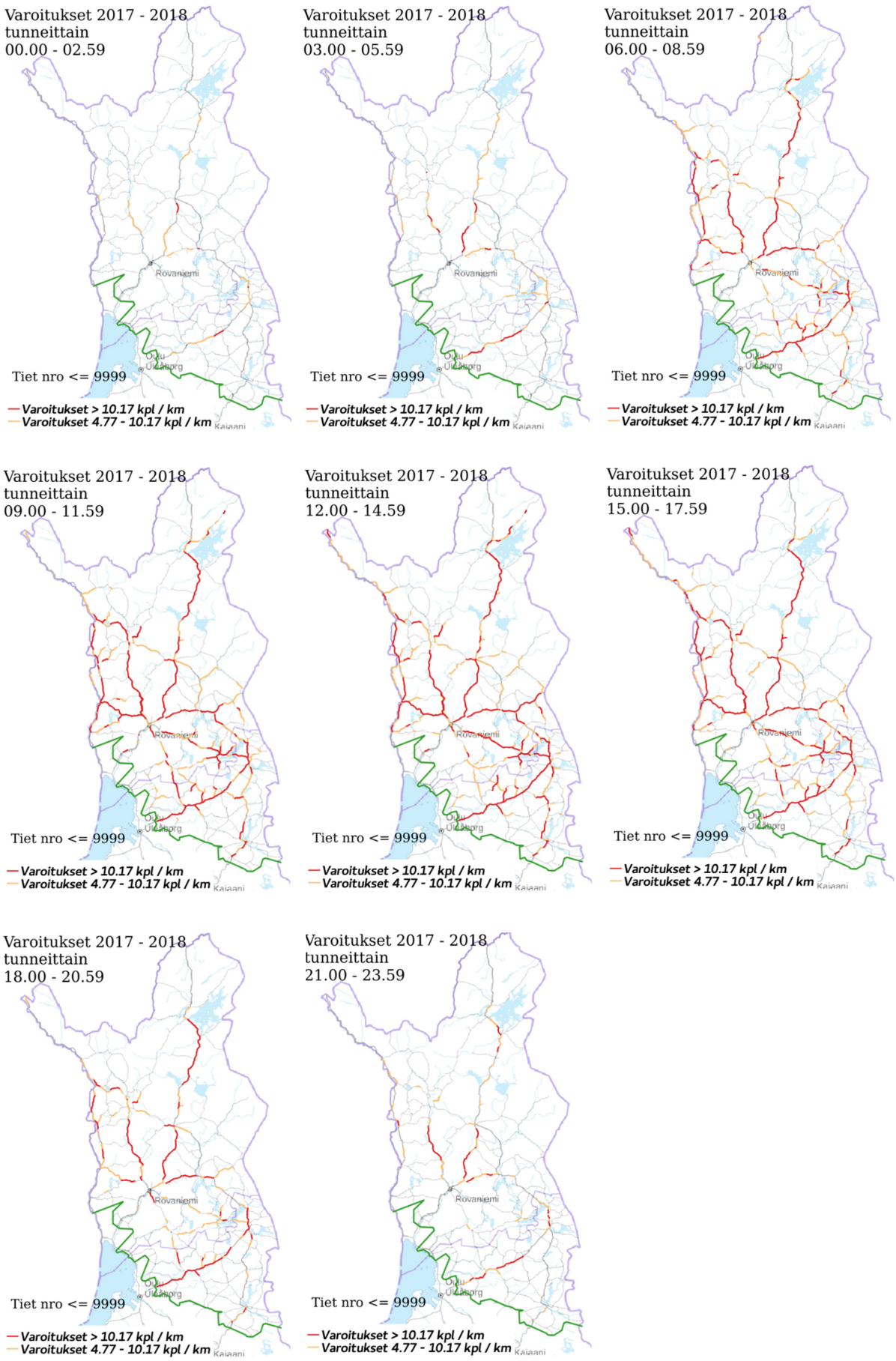


*Figure 21. Road sections with the highest **alert densities** in the reindeer husbandry area **by hour of the day** (alerts / km).*

Few alerts are issued at night excluding for the main roads, especially Highways 4 and 20, for which alerts are also issued at night.

In the hours of the morning, day and afternoon, the alerts cover the main road network relatively well and to a great extent cover the same road sections listed above with the highest collision densities. As an exception, roads with a high collision density but a low alert density in early and late mornings can be found, for example, to the east of Hetta in Enontekiö. In the afternoons and evenings, the alert density is low but collision density high on the section between Inari and Pokka. On sub-regional roads in Kuusamo and on Highway 21 to the north of Muonio, several areas with a high collision density are found at different times of the day, with a relatively low alert density.

Conclusions

The road sections with the highest alert densities in the morning, during the day and in the evenings are found on the same roads, mostly main roads, as the road sections with the highest collision densities. As many collisions occur on these road sections regardless of the alert density, it appears that the coverage of the alerts is not adequate.

- ➔ It would be justified to have more persons giving warnings in areas with road sections which already have the highest alert densities.

In addition, some areas stand out with a low alert density but a high collision density. These roads include sub-regional roads in Kuusamo with relatively busy traffic and Highway 21 north of Muonio.

- ➔ On roads where a low alert density is combined with a high collision density, more persons giving warnings are needed from the early morning till late night.

The large traffic volumes on the main roads explain the high collision densities. On road sections with low traffic volumes or in areas with a high collision density at night, the traffic volumes do not explain the collision numbers. Large numbers of reindeer move around in these areas, in addition to which factors in the high collision density may include bad conditions, for example poor visibility, or excessive speeds in the situations in question. However, it would not serve a purpose to target the marketing of the Porokello service to increase the number of persons giving warnings for roads with little traffic.

The conclusions in this Chapter are based on the assumption that the alerts reduce the incidence of reindeer collisions. It should also be noted, however, that the proportion of road users receiving reindeer alerts among the daily road users is low, which is why the focus should also be on increasing user numbers.

Examination of collision and alert densities by day of the week

For road sections with the highest collision densities (collisions/km) by the day of the week, see the maps in Figure 22. In this Figure, the 10% of road sections with the highest collision densities are shown in red (collision density > 0.295 collisions/km), with the following 10% shown in orange (collision densities between 0.164–0.295 collisions/km).

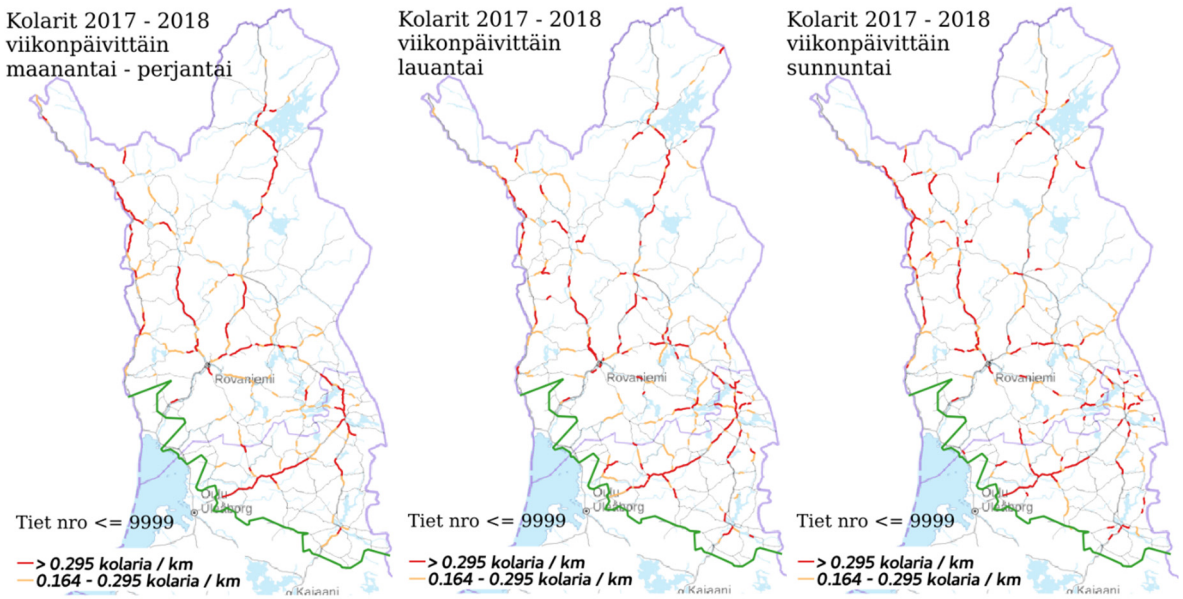


*Figure 22. Road sections with the highest **reindeer collision densities** in the reindeer husbandry area **by day of the week** (collisions / km).*

On weekdays from Monday to Friday, the road sections with the highest collision densities are found on the busiest main roads. On Saturdays and Sundays, there is more dispersion in road sections with a high collision density. All in all, the differences in collision densities between weekdays and weekends are minor.

For the road sections with the highest alert densities (alerts/km) by the day of the week, see the maps in Figure 23. In this Figure, the 10% of road sections with the highest alert densities are shown in red (alert density > 8.99 alerts/km), with the following 10% shown in orange (alert densities between 4.26–8.99 alerts/km).

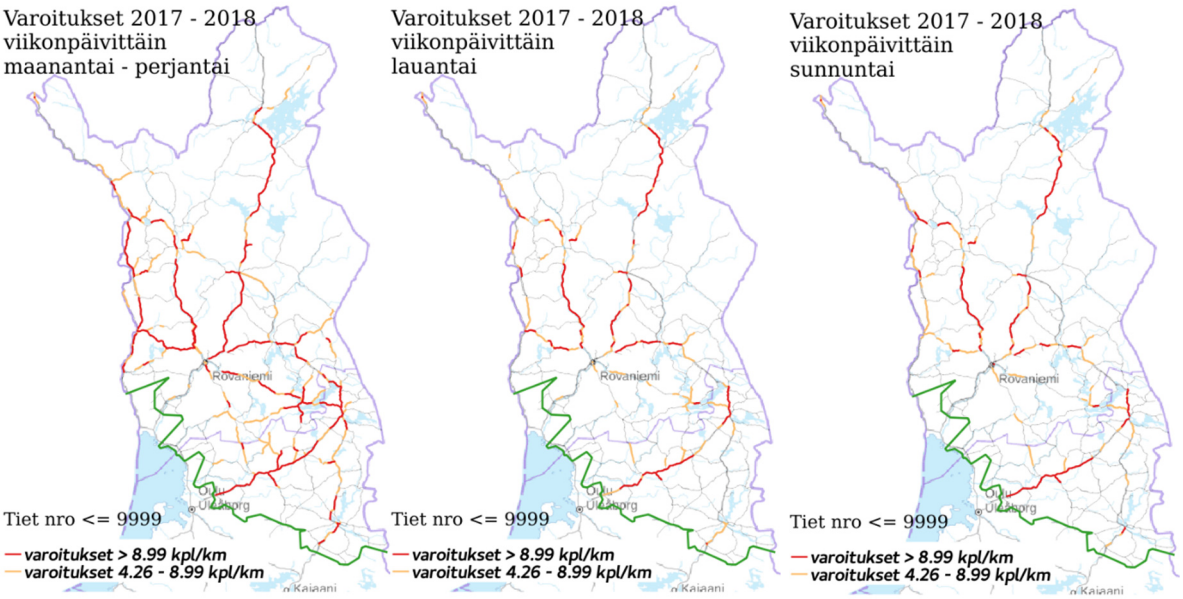


*Figure 23. Road sections with the highest **alert densities** in the reindeer husbandry area **by day of the week** (alerts / km).*

The alerts cover the main roads well from Monday to Friday. When we compare the maps of alert and collision densities, it appears that the alerts focus on the road sections with the highest collision densities. As a whole, the alert densities are lower at weekends than on weekdays, and high alert densities are found on a few main roads only. In the areas of Suomussalmi, Ranua, Posio, Kuusamo (excluding Highway 5) and Salla as well as on Highway 21 north of Muonio and around Hetta in Enontekiö, for example, a relatively high number of collisions occurs at the weekends, whereas the alert density is low.

Conclusions
As a high number of collisions occur on main roads regardless of their high alert densities, we may conclude that the impact of the alerts is not yet sufficient. The reason for this may be the inadequate number of road users receiving alerts.

- ➔ More persons giving warnings are needed on the roads at weekends when the collision density at lower traffic volumes is similar to weekdays but the alert numbers as a whole are considerably lower.

Analysis of collision and alert densities by quarter

For the road sections with the highest collision densities (collisions/km) by quarter, see the maps in Figure 24. In this Figure, the 10% of road sections with the highest collision density are shown in red (collision density > 0.525 collisions/km), with the following 10% shown in orange (collision densities between 0.256–0.525 collisions/km).

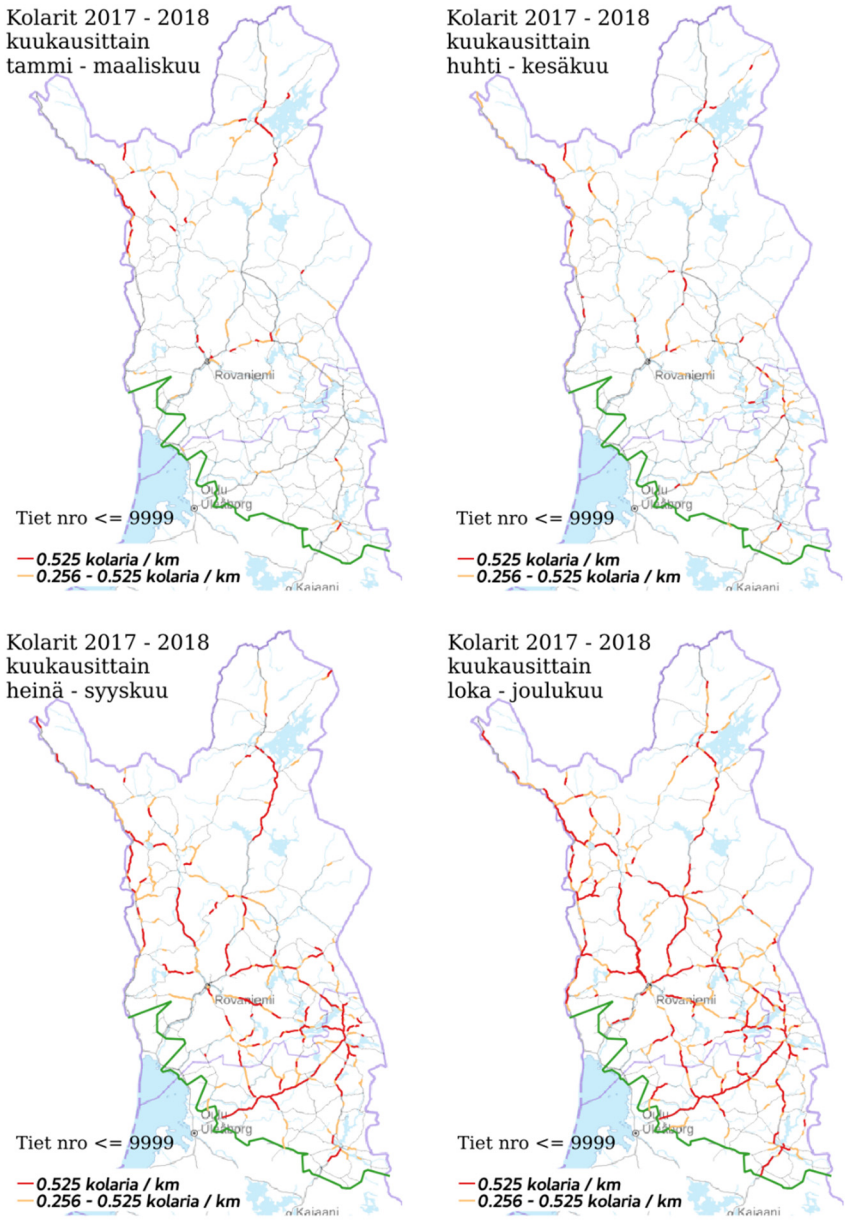


*Figure 24. Road sections with the highest **reindeer collision densities** in the reindeer husbandry area **by quarter** (collisions / km).*

In January–March, Highway 21 stands out regarding the section in which the reindeer are as a rule not kept in pens in winter, as do the areas of Inari and Ivalo. In the southern half of the reindeer husbandry area, the section from Rovaniemi to Kemijärvi and regional road 79 north of Rovaniemi stand out. Individual road sections with high collision densities are also found on Highway 5 between Hyrynsalmi and Kuusamo. In April–June, the collision density increases in Kuusamo and on Highway 20 west of Taivalkoski.

In July–September, the collision density increases considerably on most roads south of the Muonio–Sodankylä–Salla line. Collision densities are high everywhere on Highways 20 and 21, and the same applies to roads in Kuusamo, Posio and Ranua areas and Highway 5 in Suomussalmi. The collision density also increases on Highway 4 in northern parts of Sodankylä municipality and around Saariselkä. Towards the end of the year in October–December, high collision densities are found everywhere in the reindeer husbandry area on Highways 4 and 21 in addition to the areas listed above.

For the road sections with the highest alert densities (alerts/km) by quarter, see the maps in Figure 25. In this Figure, the 10% of road sections with the highest alert densities are shown in red (alert density > 20.13 alerts/km), with the following 10% shown in orange (alert densities between 8.677–20.13 alerts/km).

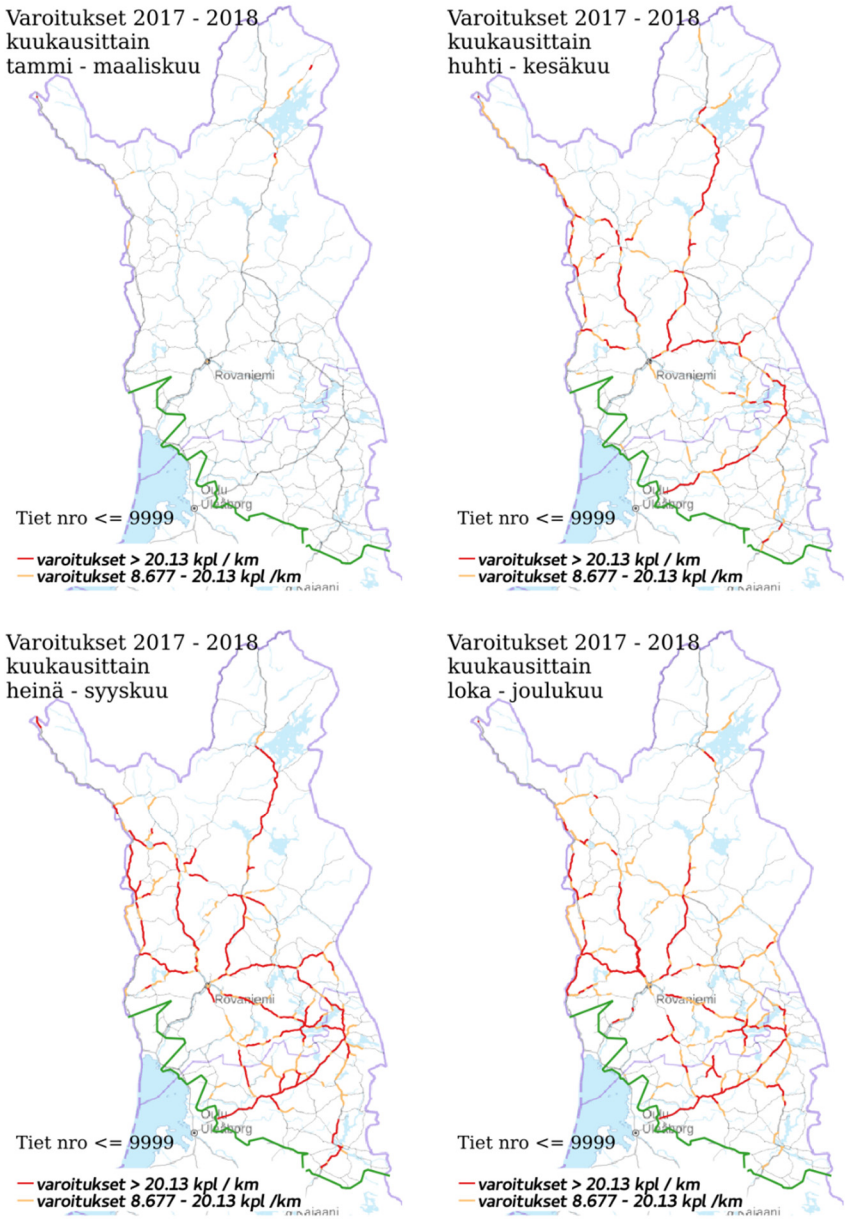


*Figure 25. Road sections with the highest **alert densities** in the reindeer husbandry area **by quarter** (alerts / km).*

In the first quarter of the year, or in January–March, the alert density is low throughout the reindeer husbandry area. Some road sections with high alert densities are found around Inarijärvi. In April–June, the alert density increases considerably on the main roads. A clear increase in density can be seen in both collisions and alerts, mainly on the same road sections, in July–September. Whereas the alert density remains high on the main roads in the last quarter of the year, the alert densities are slightly lower than in July–September.

When comparing the maps showing the collision and alert densities, the following road sections with a high collision density and low alert density can be identified:

- In January–March:
  - Inarijärvi area
  - Highway 21 north of Kolari
  - Highway 93 to the north of Hetta and the area to the east of Hetta and Ounastunturi
  - Highway 82 between Vikajärvi and Kemijärvi as well as Highway 79 in Rovaniemi
  - Highway 5 in Suomussalmi
- April–June:
  - Highway 93 to the north of Hetta and the area to the east of Hetta and Ounastunturi
- July–September:
  - areas east of Kuusamo
- October–December
  - Highway 5 in Suomussalmi
  - the section between Kuusamo, Ruka and Salla

Conclusions
The collisions clearly focus on the second half of the year in July–December. As a rule, the greatest number of alerts is given for the road sections with the most accidents, and it thus appears that the alerts focus on the correct road sections. Such sections are found, in particular, on the busy roads south of the Muonio–Sodankylä–Salla line and on Highway 4 to the north of Sodankylä.

➔ The impact of the alerts is not yet sufficient. The road users do not yet receive enough information about the reindeer. Factors in this are likely to be the insufficient number of alerts in places, the temporal distribution of the alerts, and the inadequate user numbers of the Porokello app.

Several road sections with a high collision density and low alert density can be found on the maps. See above for a list of these sections.

➔ More persons giving warnings are needed on the listed road sections with a low alert density but a high collision density.

The problem regarding Highway 21 is that a higher proportion of foreign vehicles are on the road near the border, and Porokello is thus not available for all drivers in this area.

Analysis of accident rates on the map

The accident rate indicates the number of accidents per transport performance. The higher the accident rate, the greater the risk of having an accident.

For the road sections with the highest reindeer accident rates on the map (accidents/100 million vehicle-kilometres), see Figure 26. The road sections were ranked by their accident rates, after which the sections with the highest accident rates were shown in red (10%), with the following 10% shown in orange. The red colour means that the accident rate was greater than 553 accidents/100 million vehicle-kilometres. On the orange road sections, the accident rate was 342–553 accidents/100 million vehicle-kilometres.

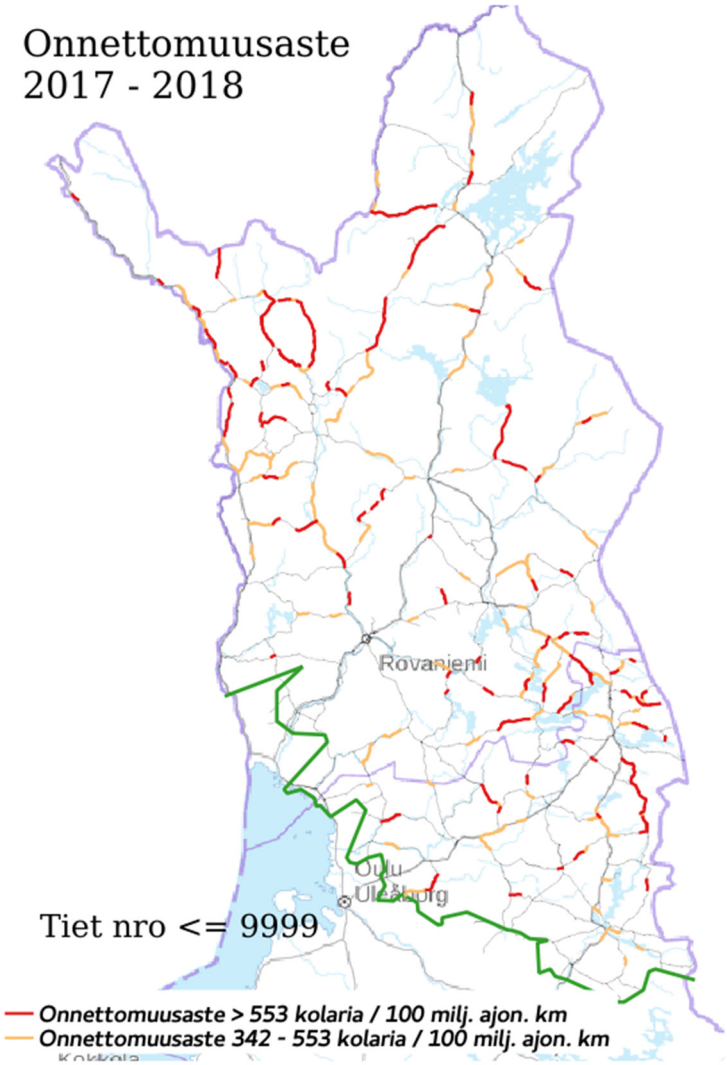


Figure 26. Road sections with the highest reindeer accident rates (accidents / 100 million vehicle-kilometres).

Conclusions

Most of the road sections with the highest reindeer accident rates are found on different roads than the road sections with the highest collision densities. Judging by their accident rates, large highways with a high collision density do not appear to be among the road sections with the highest risks. While they have a high collision density (collisions/km), due to their high traffic volumes, the accident rates (collisions/transport performance) are not among the highest. The risk of having a reindeer collision is lower here than on many roads with less traffic.

A higher than average number of road sections with a high accident rate, or a high collision risk, are found on the sub-regional roads of Kuusamo and the roads in the eastern part of Enontekiö municipality as well as the border areas of Kittilä, Kolari and Muonio (Ylläs, Pallastunturi and Ounastunturi). The roads on sections between Inari and Pokka as well as Inari and Angeli, and Savukoski and Lokka, stand out with their high collision risk.

5.3 Workshops and expert interviews

Discussions with persons giving Porokello warnings were organised at workshops in Kuusamo on 29 November 2018 and Rovaniemi on 20 December 2018. The workshop participants included three taxi drivers, three HGV drivers, a bus driver, a farm relief worker, a village association representative, an army lorry driving instructor, and three paramedics, or 13 persons in total. The participants represented both Porokello Pro app and Varottaja app users. Some gave warnings both at work and in their free time.

The discussion topics at the workshops included the practices of the persons giving warnings and the impacts of alerts on driving behaviour. An effort was also made at the workshops to investigate the motives of persons giving warnings, and the reasons for the sustained high number of reindeer collisions despite traffic safety work and Porokello were considered. The following is a list of the responses collected at the workshops.

The following viewpoints emerged concerning the practices of persons giving warnings:

- Porokello Pro app users' phones used to give warnings usually are specific to a vehicle, and giving warnings when using another vehicle for private purposes is not even possible.
- An ambulance on an emergency mission cannot concentrate on giving warnings. The ambulance dashboard already is so full of technical devices that finding space for a Porokello Pro phone is challenging. The ambulances in Koillismaa have a uniform navigation system, while a different system is used in Lapland area. The integration of Porokello in ambulance navigators was proposed.
- HGV drivers often also give reindeer alerts for elk.
- The participants believe that a good practice in giving warnings is to first focus on the traffic and possibly avoiding the reindeer, and only give the alert when it is safe to do so and allowed by the traffic situation.
- The majority of the participants always give a warning when they see a reindeer. Giving a repeat warning in an area where an alert is already valid is important also for the reason that the reindeer may have moved since the previous alert was given.
- As reindeer usually move around in herds, an observation of a single reindeer calmly feeding probably means that there also are other animals in the area, some of which may be on the move or come to the road. Giving a warning is recommended whenever a reindeer is close to the road.
- A taxi entrepreneur had noticed that on average, tourists travelling in the taxi spot a reindeer later than local residents, or not at all.
- The traditional way of giving a reindeer warning on the road is flashing the headlights. Drivers who are not locals do not necessarily understand this type of a warning.

- It was believed that if warnings could be given by anyone, this would result in a clear increase in unnecessary alerts. The participants felt that the possibility of giving reindeer warnings should also be limited to professional drivers in the future, or at least be based on an application.

According to workshop participants' experiences, the alerts have brought concrete benefits. The following observations were made on the impacts of the alerts on driving behaviour:

- The driving behaviour of a driver who has received a reindeer alert becomes clearly more alert; it 'wakes up' the driver.
- The way the reindeer behave (stand calmly on the side of the road, run along the road etc.) affects the way drivers change their behaviour when spotting the animals.
- From the perspective of a HGV driver or a transport entrepreneur, the alerts support anticipation of situations on the road (reduce the incidence of breaking suddenly when seeing reindeer), which brings savings in fuel and vehicle maintenance costs.
- For a taxi entrepreneur, a key reason for being careful is responsibility for customers.
- The alerts are experienced as useful, especially in an unfamiliar environment where the driver is not aware of locations with a high reindeer collision risk.
- The great number of alerts is sometimes frustrating. The participants also expressed their concern over some of the tourists giving up using the app due to constant alerts.
- On familiar roads, drivers usually know the locations with a high risk of reindeer collisions, and repeated alerts in these areas may be frustrating.
- When driving in the dark, reindeer alerts increase driver alertness and 'wake up' the driver. The participants found that a good number of alerts is also received at night.
- Many of them supported the proposal of reindeer alerts remaining valid for longer at night when fewer persons giving warnings are out and about.
- Too few alerts are issued for the paved roads of the lower-grade road network which are used by few professional drivers. The number of alerts is also lower at weekends, as fewer professional drivers are on the road.
- Not all persons giving Porokello warnings were aware of the map service in the app showing the up-to-date locations of alerts. Some check the alerts on the map whenever they start off.

The following were listed as factors motivating drivers to give warnings and use Porokello:

- if the service is useful for drivers and society, why not use it
- savings brought to HGVs by anticipating situations on the road

- preventing personal injuries and damage to vehicles, both your own and other drivers'
- reducing costs for reindeer herders and society
- avoiding another reindeer collision
- the reindeer is an essential part of Northern Finland.

When the participants considered why great numbers of reindeer collisions continue to occur regardless of traffic safety work and Porokello, the following viewpoints were put forward:

- Reindeer behaviour cannot be anticipated, and it is simply impossible to be prepared for all situations in advance.
- In the insect season, reindeer movements on the road are restless and unpredictable.
- Tourists' driving behaviour is experienced as careless. Some drive extremely fast in high reindeer collision risk areas. In general, the participants found that speeding is often a factor in reindeer collisions.
- Spreading salt on the roads was mentioned as a factor that increases reindeer collisions. The salt draws reindeer to the road and often makes the roads more slippery when the temperature drops.

When talking about reindeer collisions in general, the following viewpoints also came up in interviews with a reindeer herder and a road traffic loss assessor:

- In spring, the reindeer are difficult to see against the road margin because of their colour. The road margin is still grey in colour after the winter. The winter feeding of reindeer also ends around this time.
- Drivers' attitudes towards other road users have taken a turn for the worse in recent times. Fewer drivers stop to help others on collision sites. Driving carelessly on accident sites is also more common, which makes the assessor's work more dangerous. People often also are helpless on accident sites and do not know what to do.
- According to road traffic accident assessors, people who run into reindeer sometimes fail to report the collision. The reasons for this may include high speeds. Sometimes the report is made by a vehicle driving behind the one involved in the accident. At times the driver does not necessarily even notice they have hit a reindeer. In particular, this is true for HGVs.
- The reindeer herder pointed out that the Emergency Response Centre should be informed of all reindeer collisions, ensuring that it is also aware of an assessor who may carry a firearm.
- The bright headlights of a vehicle may dazzle the reindeer.
- When the herd gets a fright, reindeer dash in all directions. If one or several reindeer are running on the road, this indicates that animals may pop up on the road from several directions.

- In places, reindeer cross the road at the same point several times a day if the local topography, such as rivers, limits their route choices. Many collisions take place on regular routes followed by reindeer.

- While reindeer collisions occur in all types of terrain, typical locations vary at different times of the year. In spring, the highest number of collisions happen in spruce forests.

- Reindeer collisions occur on all types of roads and in all speed limit zones. On straight roads with a good visibility, high driving speeds are a factor that increases collision numbers.

- Fences intended to prevent traffic accidents (which double as fences around pastures) are used to the south and north of Sodankylä, for example. It has been estimated that the reindeer fences in Sodankylä have reduced the number of reindeer collisions. A fence has been erected along the railway line between Rovaniemi and Tervola, which also restricts reindeer access to Highway 4. There are no game fences between Oulu and Kuusamo.

- Collisions occur at certain times on roads at fences between herders' cooperatives, as reindeer follow the fence to the road.

- The number of direct personal injuries caused by reindeer collisions is very small considering the number of collisions. A hazardous type of reindeer collision is one where the reindeer is thrown up in the air at the collision point, landing on the windscreen of another vehicle. Attempts to avoid reindeer may result in driving off the road or head-on collisions.

5.4 Internet surveys

Responses to the Internet survey were received from 55 persons giving warnings. The number of persons actively giving warnings at the daily level is around 350. Currently, 710 phones with the Porokello Pro app are in use. One phone may be used by several persons to give warnings. The number of persons using the Varottaja app to give warnings is around 600.

The share of professional drivers among the respondents was relatively low, or 16%. This is partly due to the fact that reaching professional drivers who use alert phones organised through their employers is challenging for Porokello communications, and not all drivers thus received enough information about the survey. Besides professional drivers, warnings are also given by farm relief workers, Natural Resources Institute Finland's researchers and entrepreneurs.

Responses to the survey were received from 126 Porokello app users. The typical daily user numbers are 300 to 600.

More than one half of the survey responses were given in January. This is why it should be noted that some of the responses were given at a time when a large part of the reindeer were being fed in the forest or kept in pens over winter. Among other things, this has an impact on responses related to the latest encounter with a reindeer or the latest alert.

A summary of the responses is given below. The responses of persons giving warnings and app users were combined where appropriate. All responses to the

survey are attached to this report. Responses to open-ended questions were taken into account when analysing the responses but not included in the report.

Part 1 – background questions

Background information of persons giving warnings

Respondents in the survey addressed to persons giving warnings were more or less evenly divided between different age groups. The greatest number of respondents were in the age group 41 to 50 (31%).

55% of the respondents said they or persons close to them owned reindeer. The respondents came from all around the reindeer husbandry area.

Of the professional drivers who responded, 45% had been working in their occupation for 6 to 10 years, whereas 44% had been working in it for over 10 years. More than one out of two professional drivers said the yearly distance they drive for work was 50,000 to 100,000 km. For those who were not professional drivers, the yearly driving distance mostly was between 10,000 and 30,000 km.

The majority of the respondents (48) had the Varottaja app on their personal phones, whereas 10 respondents had a separate phone for giving warnings. In addition to either one of the apps intended for giving warnings, eight respondents also used the Porokello app. 14% of the respondents had been giving warnings since late 2016, while 44% had only started doing so in late 2018.

72% of the respondents always had the Porokello app on when driving in the reindeer husbandry area, and 9% had the app on occasionally. 17% of the respondents only kept Porokello on at the times when they expected the collision risk to be high, and 2% only had it on in an unfamiliar environment.

Users' background information

The greatest number of respondents among Porokello app users were in the age groups 51 to 60 (34%) and 41 to 50 (26%), while the smallest number was found among those aged under 30 (10%).

The majority of the respondents said they or persons close to them owned reindeer (77%). Slightly more than one half of the respondents lived in the reindeer husbandry area (53%), while 16% only visited the area occasionally. Based on the open-ended responses, the roads travelled by the respondents represented relatively well the entire reindeer husbandry area.

The respondents' annual driving distances were mostly between 10,000 and 30,000 km (59%). Approx. one out of three respondents said they drive more than 30,000 km a year. One half of them lived in the reindeer husbandry area.

66% of the respondents had started using Porokello in late 2017. Almost one half of the users drive less than 5,000 km a year with the app on. Only 6% drive over 30,000 km a year using the app. Of those who drive a lot (>30,000km/year), more than one half use Porokello over a distance exceeding 10,000 km a year.

11% of the respondents said they used the app daily, whereas 30% used it weekly, 32% monthly and 27% less often than this. Of those who drive a lot, 20% use Porokello on a daily basis, 28% weekly, 30% monthly and 22% less often than that.

Of those who responded, 74% always have the Porokello app on when driving in the reindeer husbandry area, and 15% have the app on occasionally. 8% of the respondents only kept Porokello on at times when they expected the collision risk to be high, and 3% only had it on in an unfamiliar environment. These percentages are more or less the same among those who drive great distances.

Experiences of reindeer and reindeer alerts

The background questions also included ones that charted the respondents' experiences of reindeer and the alerts as well as the motives of those giving warnings. When persons giving warnings were asked how often they had already received an alert when encountering a reindeer, more than one half of the respondents said that less than 40% of the encounters had been preceded by an alert (Figure 27).

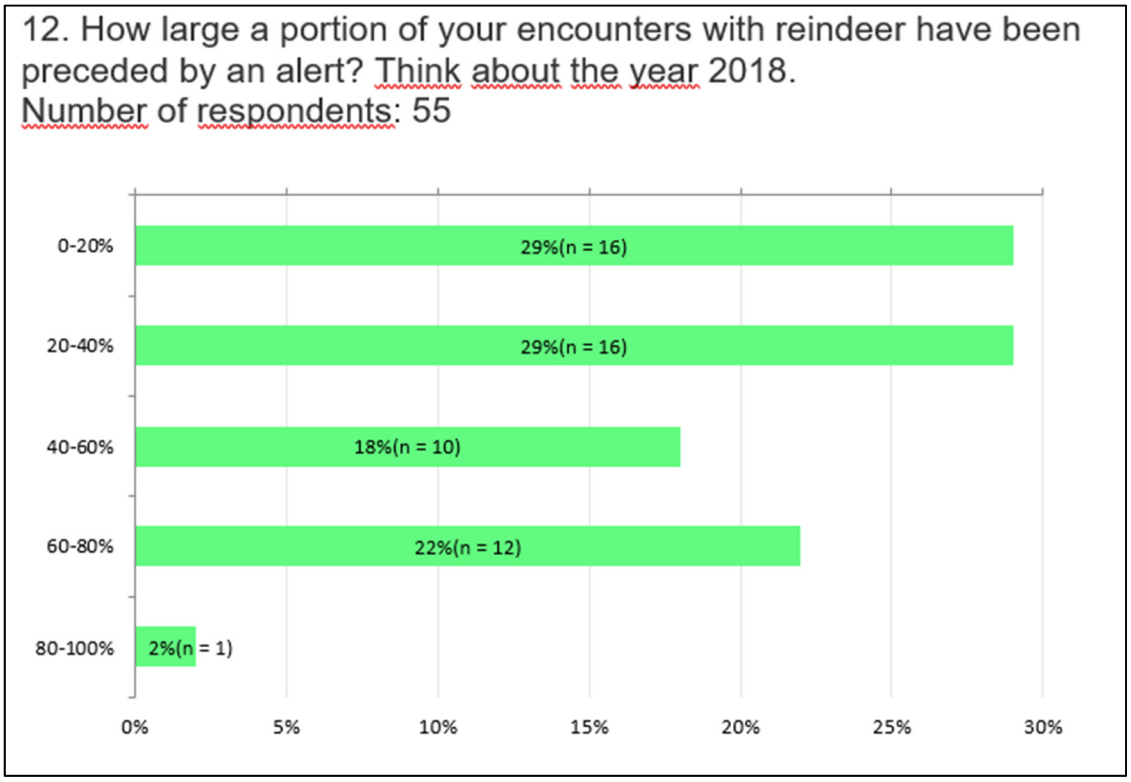


Figure 27. Proportion of reindeer encounters preceded by an alert. Results of the survey among Varottaja app users.

As the main motives of persons giving Porokello warnings were cited a desire to reduce the number of reindeer collisions, to warn other road users, and to promote traffic safety. Other motives included a desire to reduce the harms and costs caused by reindeer collisions, a personal willingness to give reindeer warnings, and a desire to become involved in developing new technology. Outside the ready-made response options, a desire to protect reindeer was also mentioned (2 respondents). None of the persons giving warnings cited being obliged by the employer as their motive.

When asked about the last time they had given a warning, more than one half of persons giving warnings said they had done so in the last week (Figure 28). As the survey was conducted at the turn of the year, it is possible that some of these persons gave their responses at a time when most reindeer were already being fed in the forest or kept in winter pens.

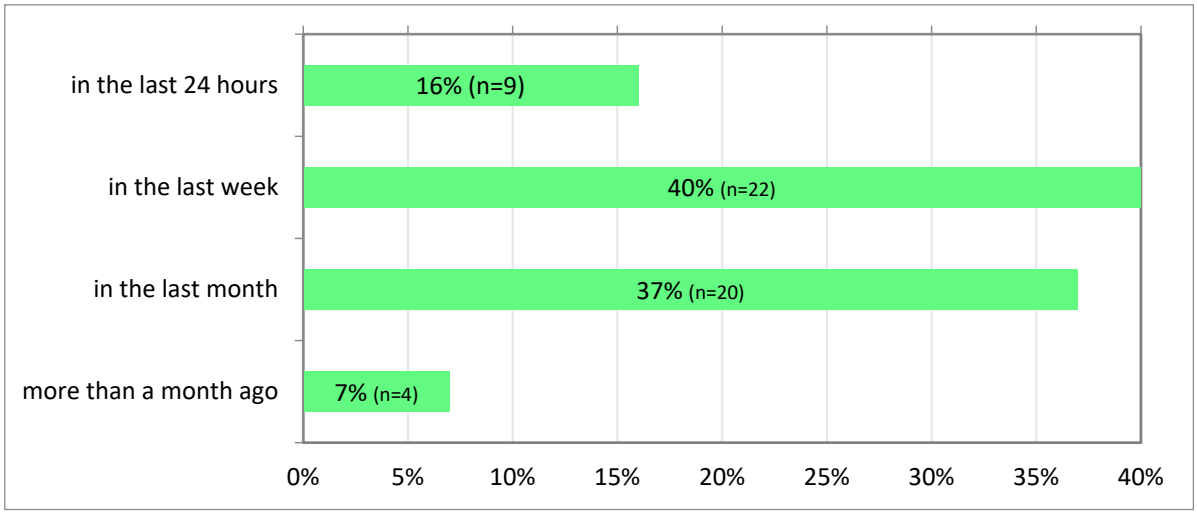


Figure 28. The most recent time the respondent gave a warning. Results of the survey among Varottaja app users.

95% of persons giving warnings said they always give a new warning in an area covered by an alert when they see a reindeer.

In a response directed at users concerning the impacts of Porokello's existence, 62% of the respondents felt that it made them more observant of reindeer in general. For 2%, the opposite was true. 26% felt that the existence of the Porokello alert system does not affect the manner in which they keep a lookout for reindeer. An alert issued by Porokello affects the driving behaviour of almost all drivers, whereas seeing a reindeer reinforces this impact among 88% of the respondents.

Experiences of collisions

24 persons giving warnings and 31 users had had one or several reindeer collisions. Five had had the Porokello app on when the collision occurred, and in one of these cases, the respondent had received an alert.

Around two out of three users and persons giving warnings felt an alert had helped them avoid a collision (Figure 29).

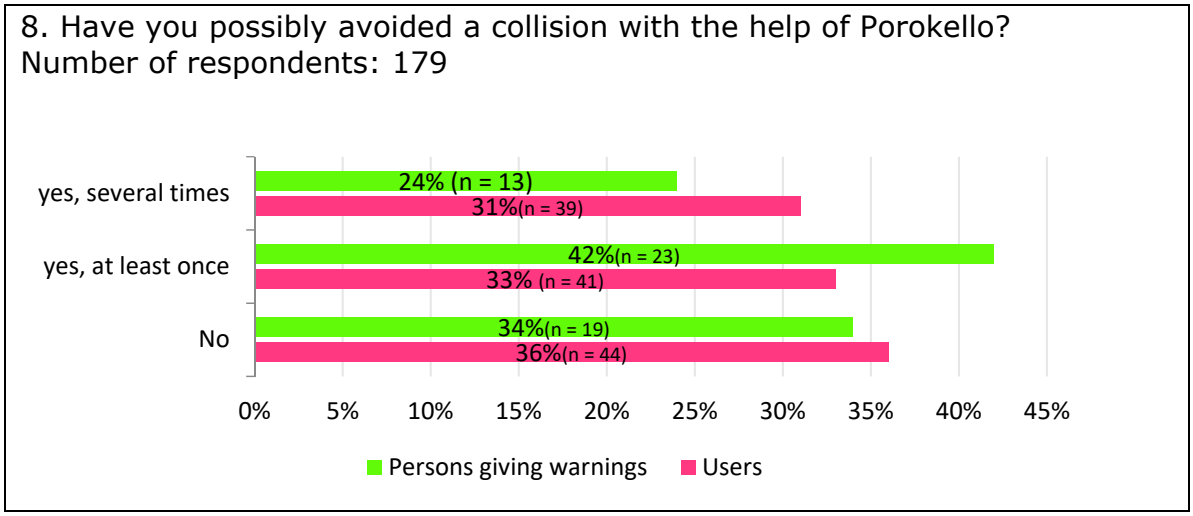


Figure 29. Alert helped to avoid a collision. Survey results, combined results of persons giving warnings and users.

Part 2 – receiving an alert

Selected incident (both persons giving warnings and users)

In the second part of the survey, the respondents were asked to recall the last time they had received a Porokello alert. To make sure the respondents recalled the incident as accurately as possible, they were asked to describe the situation verbally. In the context of this incident, they were asked about their observations of reindeer and the impacts of the reindeer alert on their driving behaviour.

More than 70% of the respondents had observed reindeer in the area after receiving an alert. In over one half of the cases, the reindeer had been on the road margin, whereas more than 30% of the respondents said the animals had been on the road. Approx. 80% said they would also have seen the reindeer without the alert. 67% of the persons giving warnings and 89% of the users felt the alert helped them see the reindeer earlier than they would otherwise have done. 91% of the persons giving warnings and 88% of the users said they had taken precautions and changed their driving style because of the alert. Fewer than one out of three believed they had avoided a collision thanks to the alert.

Impact of alerts on driving behaviour

The respondents were asked to assess in greater detail how the alert they received had affected their driving behaviour. The respondents were asked to compare the situation before and after receiving the alert.

They were asked about impacts on the following factors:

- driving speed
- distance to the vehicle ahead
- overtaking
- use of control devices
- activities performed while driving
- talking about the alert
- focusing attention
- other impacts.

The questions used in the Internet survey were mostly those formulated for a prior study (Aittoniemi et al. 2015). The questions were posed in a different manner than in the previous study, however. In the earlier study, the questions were asked in an interview: the respondents were first given an opportunity to respond spontaneously, after which more detailed impacts related to each factor were suggested to them. In the Internet survey, multiple choice questions about detailed impacts were included, in which the respondents could select several options.

Impacts of alerts on driving behaviour that came up in interviews carried out as part of the previous study regarding different factors are shown in Figure 30.

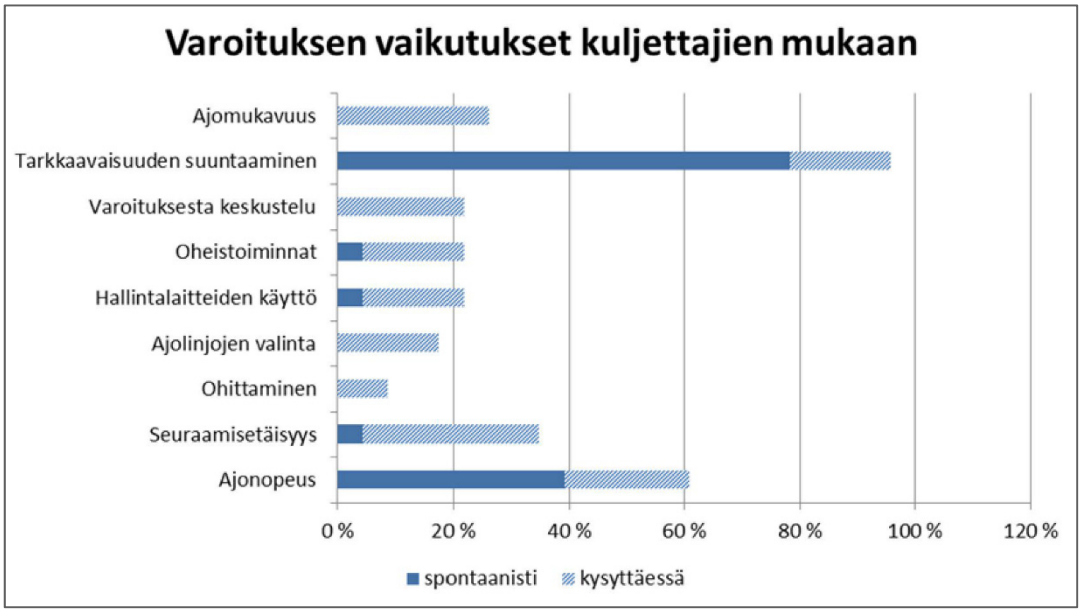


Figure 30. Impacts of alerts on driving behaviour mentioned spontaneously and when asked (n=25) (Aittoniemi et al. 2015). Columns top-down: Driving comfort, focusing attention, discussing the alert, activities performed while driving, use of control devices, choice of lines, overtaking, distance to the vehicle ahead, driving speed. Captions below the graph: Spontaneously; When asked.

The results regarding impacts on the driving behaviour of persons giving warnings and users obtained in the Internet survey are shown in the graph in Figure 31. The percentages have been calculated assuming that if the respondent did not say "no effect", "cannot say", or "only had an impact when I saw a reindeer", the alert had had an effect on the factor in question. As the respondents were able to select several detailed impacts under each factor, the totals of the percentages for different impacts could not be calculated.

As in the previous study (Aittoniemi et al. 2015), effects on focusing the driver's attention came up as the most important impacts. During the Porokello trial, impacts on driving speeds and overtaking behaviour were significantly greater than in the previous trial of a reindeer alert service. Talking about the alert was also more common during the Porokello trial. Part of the reason for this probably is that in the previous study, the service was only trialled by professional drivers, who mostly were driving alone.

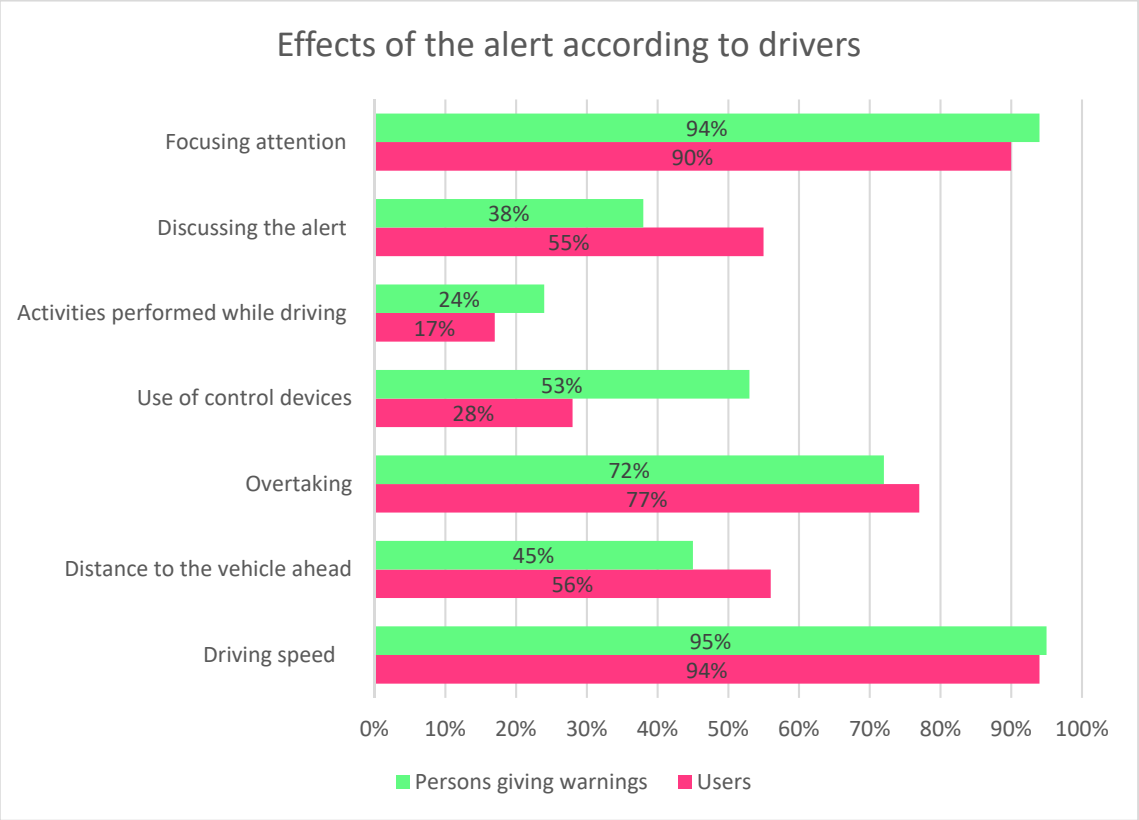


Figure 31. Effects of the alert on driving behaviour according to the Internet survey ($n_{persons\ giving\ warnings}$=55 and n_{users}=126).

According to the Internet survey, in the selected incidents the alert had the greatest impact on focusing the driver's attention and the driving speed. In focusing the driver's attention, as key impacts on identified factors were cited keeping a lookout for possible reindeer and other animals on road margins; this was mentioned by 87% of the persons giving warnings and 82% of the users. For other identified impacts associated with alertness and their proportions in the responses, see Figure 32. The number of options the respondents could choose was not limited. In the freely worded text field (question: in other ways, how?) looking for animal tracks in the snow was also mentioned.

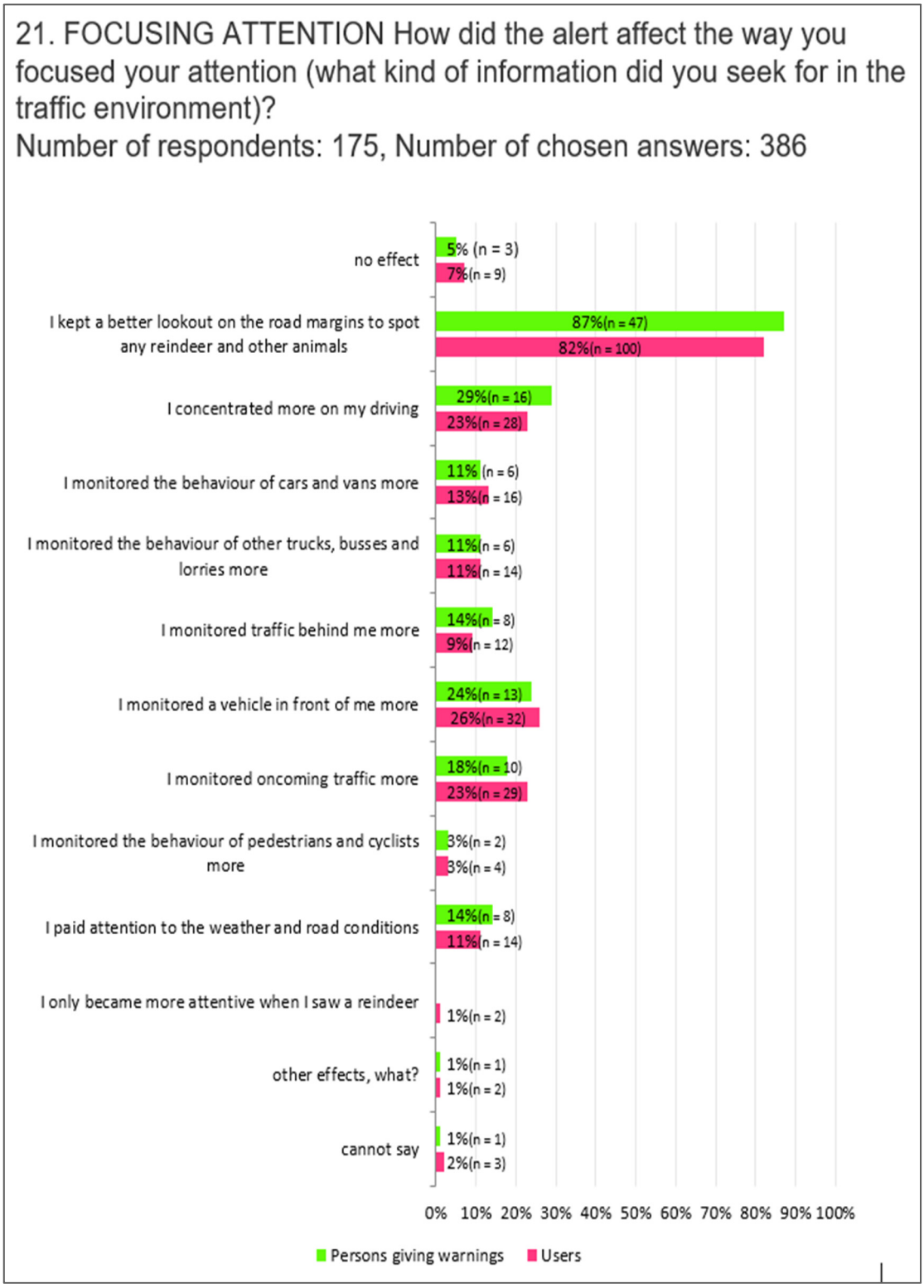


Figure 32. Impact of an alert on focusing the driver's attention. Survey results, combined results of persons giving warnings and users.

The alert had an almost equal impact on the driving speed as on alertness: 87% of the persons giving warnings and 81% of the users said they had slowed down after receiving an alert. For other identified impacts associated with driving speed and their proportions in the responses, see Figure 33. The number of options the respondents could choose was not limited. In the freely worded response fields, such aspects as increased general alertness were mentioned.

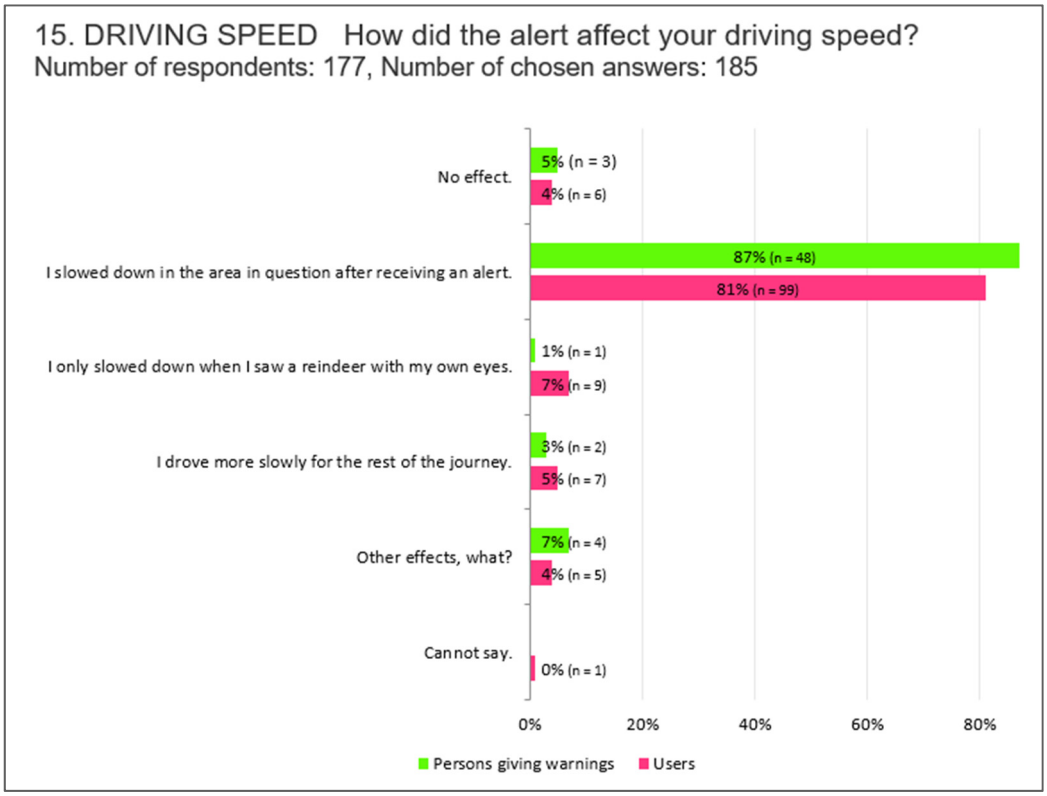


Figure 33. Impacts of the alert on driving speed. Survey results, combined results of persons giving warnings and users.

Other significant impacts on driving behaviour mentioned by the respondents were:

- overtaking: I attempted to avoid all overtaking (persons giving warnings 51%, users 54%)
- distance to the vehicle in front of you: I maintained a longer distance to the vehicle in front of me (persons giving warnings 45%, users 55%)
- talking about the alert: I talked about the purpose of the alert with a passenger (persons giving warnings 31%, users 51%).

Part 3 – general questions about Porokello

Acceptability of Porokello

To measure the acceptability of Porokello, the same metrics were used as in a previous study (Aittoniemi et al. 2015). Satisfaction with the service was measured with a battery of questions where the respondents were asked about their opinion of the alert's features (Figure 34).

41. How satisfied are you with Porokello? Give your opinion on a numeric scale.

	Very satisfied	Quite satisfied	Neither satisfied or dissatisfied	Quite dissatisfied	Very dissatisfied
Comprehensibility of the alert	○	○	○	○	○
Reliability of the alert	○	○	○	○	○
Timing of the alert	○	○	○	○	○
Usefulness of the alert	○	○	○	○	○
Noticing an incoming alert	○	○	○	○	○
Giving warnings	○	○	○	○	○

Figure 34. Questions used in the survey to measure satisfaction with the service.

Figures 35–36 show the distribution of opinions obtained in the survey. Based on the responses received, almost all respondents were highly satisfied or rather satisfied with all features of the alerts. The majority of the respondents were highly satisfied with the comprehensibility and usefulness of the alert and the visibility of incoming alerts. Responses indicating dissatisfaction were only received from a few persons giving warnings. Among users, 11% of the respondents were dissatisfied with reliability of the alerts, while 7% were dissatisfied with their timing. Approx. 5% of users were dissatisfied with other features.

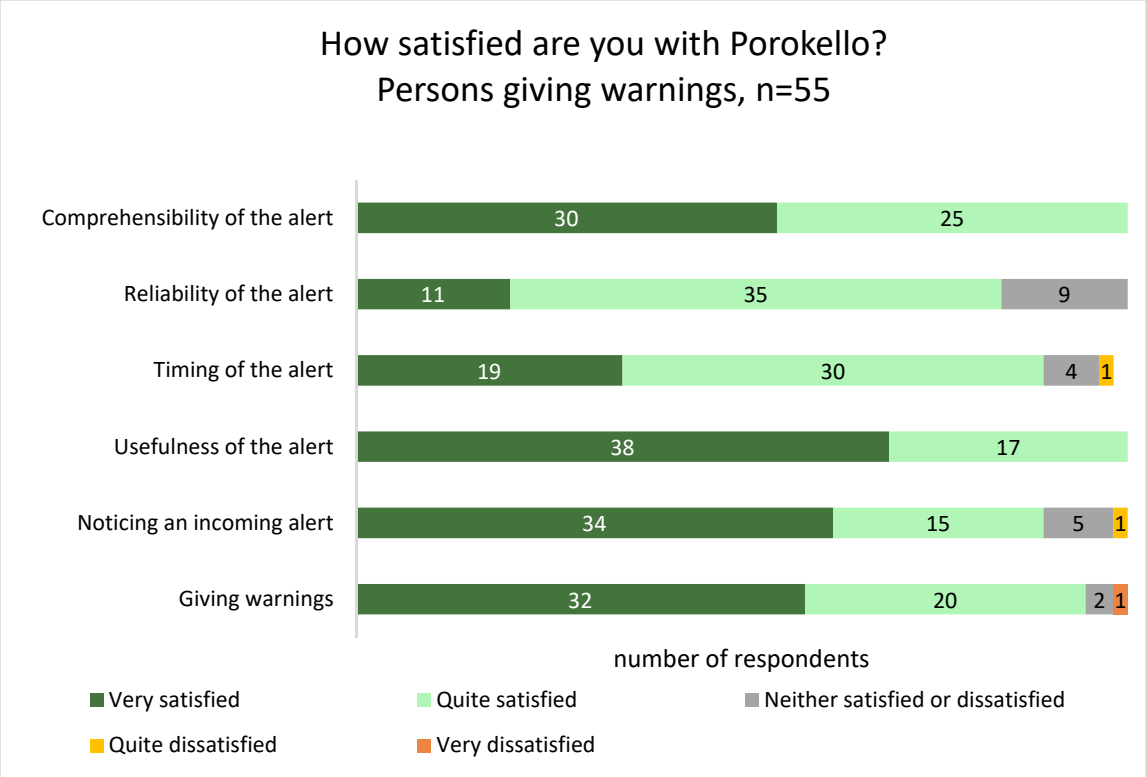


Figure 35. Satisfaction with Porokello among persons giving warnings, distribution of responses.

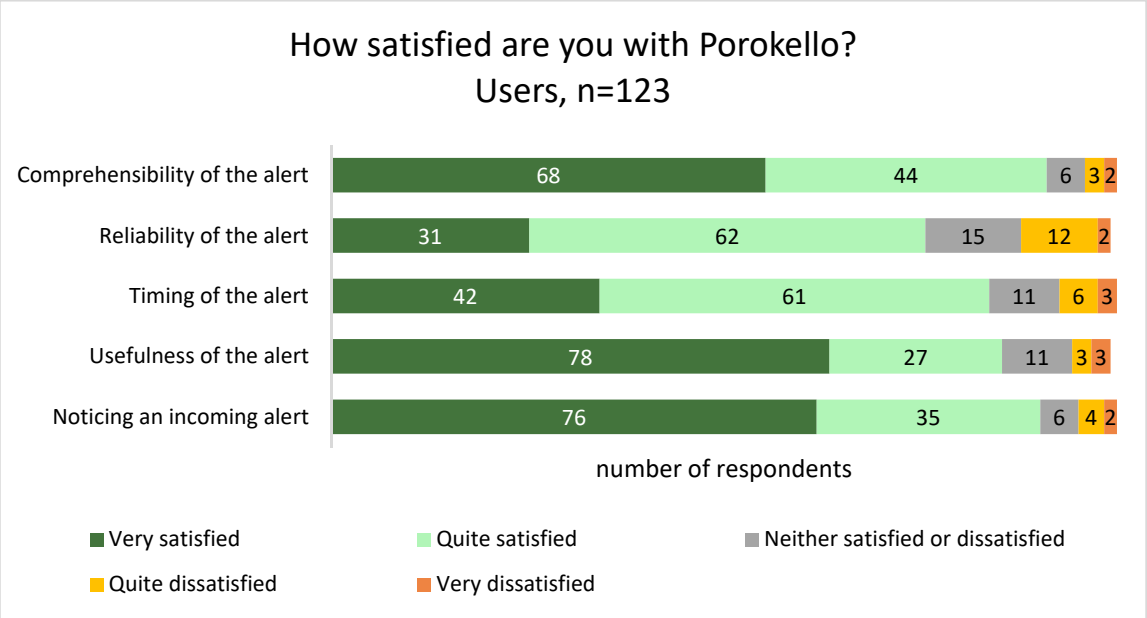


Figure 36. Satisfaction with Porokello among users, distribution of responses.

To compare the responses with the findings of a previous study (Aittoniemi et al. 2015), a numeric value was calculated to describe satisfaction. Numeric values between -2 and 2 were assigned to the responses ranging from highly dissatisfied to highly satisfied, and averages for these figures were calculated. The results concerning satisfaction obtained in this manner are shown in Figures 37 and 38. The persons giving warnings were slightly more satisfied on average than the users.

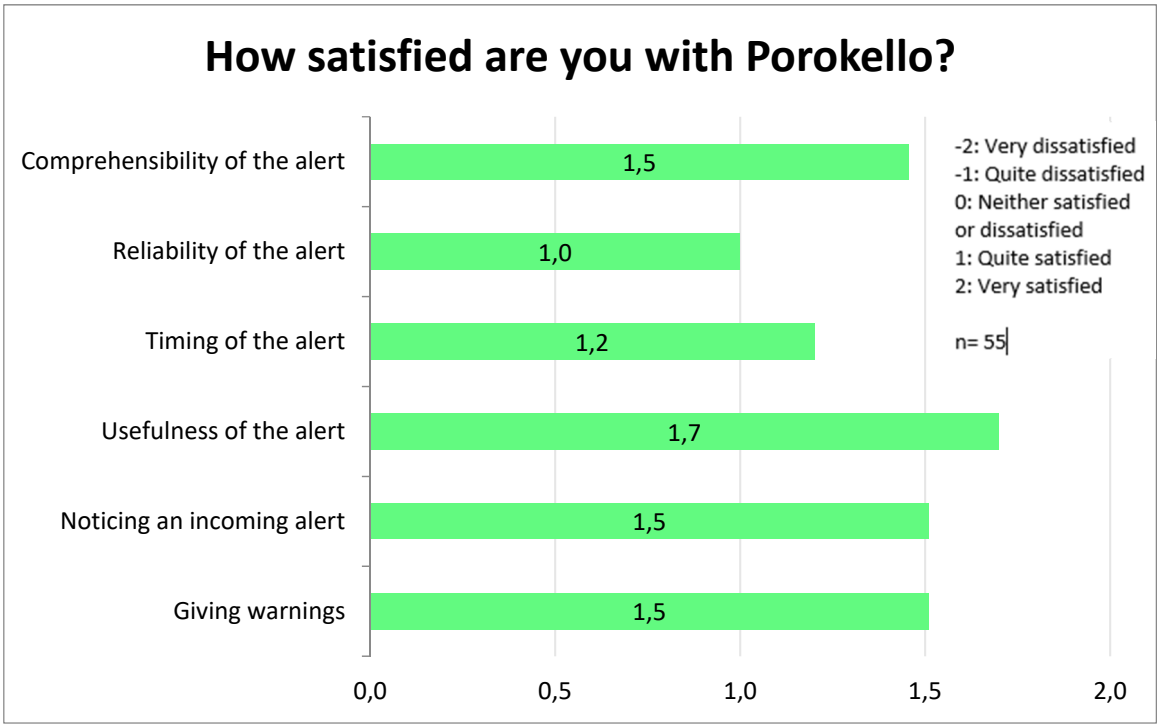


Figure 37. Satisfaction with Porokello among persons giving warnings.

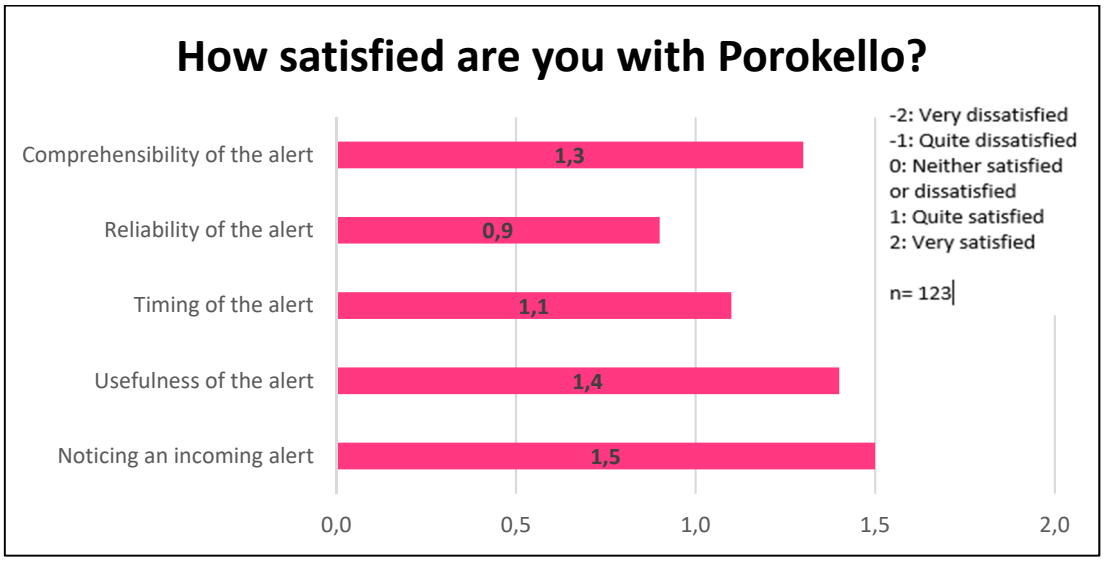


Figure 38. Satisfaction with Porokello among users.

This comparison indicates that the survey results were similar to the findings of a previous study (Aittoniemi et al. 2015). Figure 39 shows a graph illustrating drivers' satisfaction with the service in the previous study. Compared to the previous study, satisfaction with the reliability and timing of the alerts was at a slightly higher level. Satisfaction with the comprehensibility of the alert, visibility of an incoming alert and the giving of warnings was slightly lower than in the previous study. The level of satisfaction with the usefulness of the alerts was higher among persons giving warnings than in the previous study.

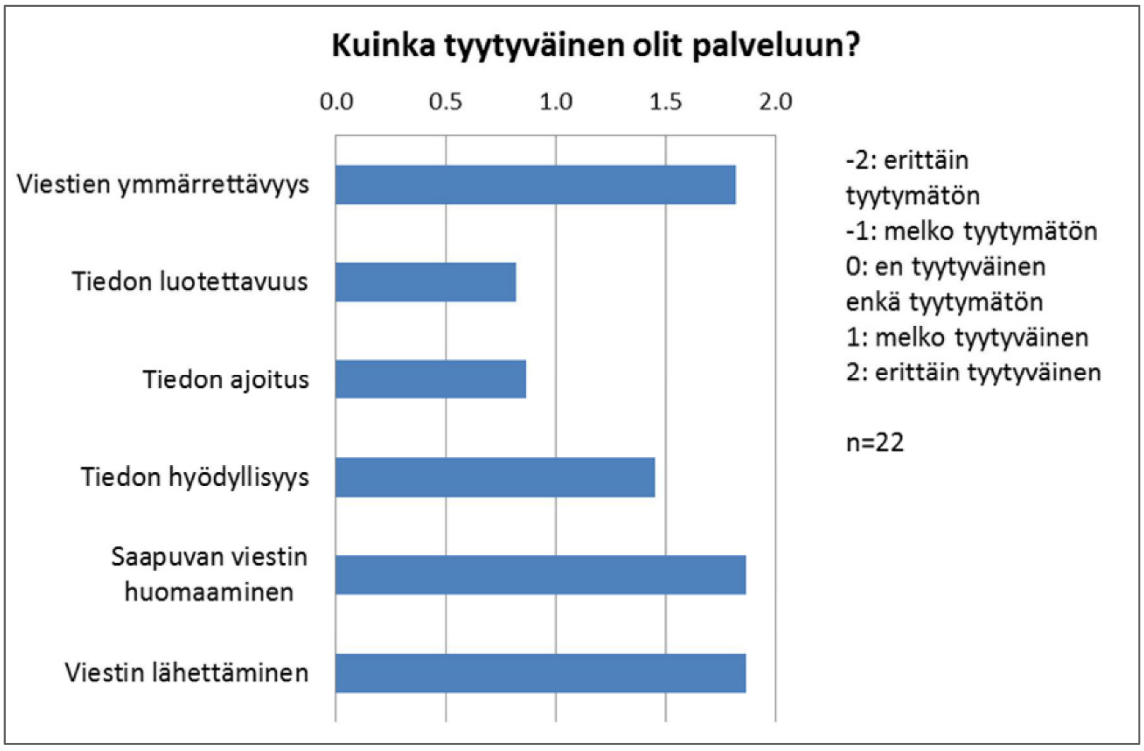
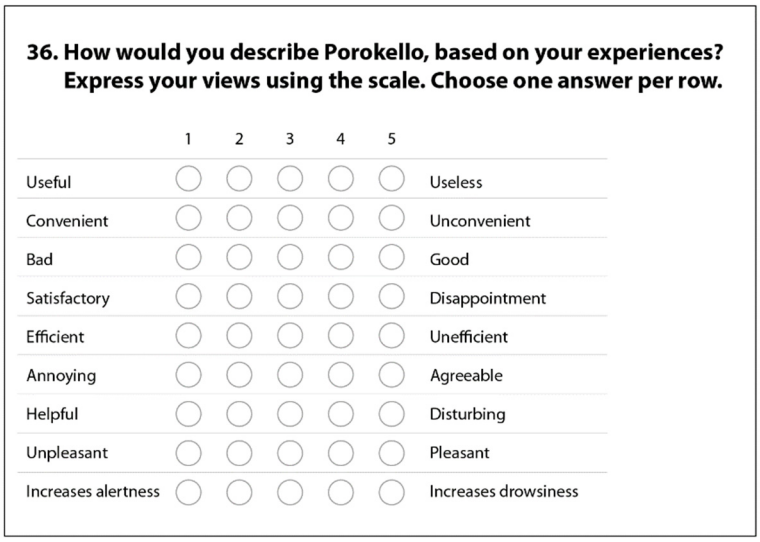


Figure 39. Driver satisfaction with the reindeer alert service in a prior study in 2015 (Aittoniemi et al. 2015). Columns top-down: Intelligibility of the messages, reliability of the information, timing of the information, usefulness of the information, recognising the incoming message, sending a message. Captions on the right: -2 very dissatisfied, -1 quite dissatisfied, 0 neither satisfied nor dissatisfied, 1 quite satisfied, 2 very satisfied.

As another indicator for the acceptability of the service, the Van der Laan scale was used. The survey included a table with nine rows (Figure 40), the results of which can be presented as two numeric values describing usefulness and satisfaction. The respondents were asked about their opinion of the service and given two extremes, such as useful and useless, and they expressed their views using a five-step scale. The response closest to useful is given the weighting 2, while the response closest to useless is given the weighting -2. Finally, the results are summed up in two figures describing the usefulness of the service and satisfaction with it. (Aittoniemi et al. 2015; Van der Laan et al. 1997).



36. How would you describe Porokello, based on your experiences? Express your views using the scale. Choose one answer per row.

	1	2	3	4	5	
Useful	○	○	○	○	○	Useless
Convenient	○	○	○	○	○	Unconvenient
Bad	○	○	○	○	○	Good
Satisfactory	○	○	○	○	○	Disappointment
Efficient	○	○	○	○	○	Unefficient
Annoying	○	○	○	○	○	Agreeable
Helpful	○	○	○	○	○	Disturbing
Unpleasant	○	○	○	○	○	Pleasant
Increases alertness	○	○	○	○	○	Increases drowsiness

Figure 40. Table with nine rows used in the study to calculate numeric values for usefulness and satisfaction.

For the results, see Figure 41. The respondents found the service useful (figure for persons giving warnings 1.47 and for users 1.32) and they were relatively satisfied with it (1.12 and 1.04). The Figure also shows the results of the previous study.

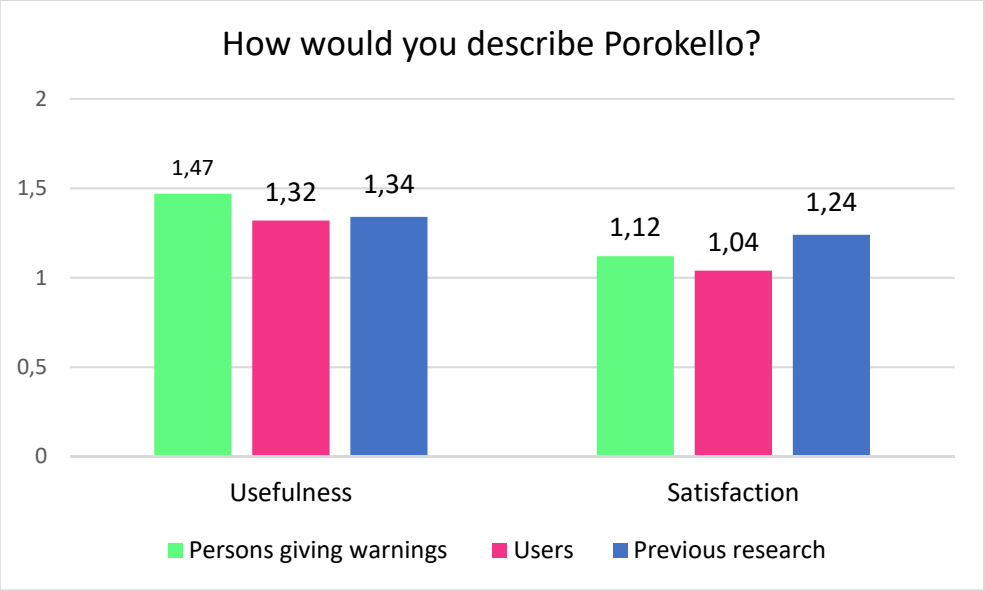


Figure 41. Usefulness of and satisfaction with Porokello alert service.

Based on this indicator, too, the survey results were similar to the findings of the previous study (Aittoniemi et al. 2015). Persons giving warnings found Porokello even more useful than in the previous study. The respondents were relatively satisfied with Porokello, as they were with the reindeer alert system in the previous study; however, this indicator showed a slightly lower level of satisfaction with Porokello.

The respondents to the Internet survey were asked about what they thought would be a suitable duration for an alert and who could give alerts. More than one half of the respondents found that the current period of validity, or half an hour, was suitable (Figure 42). 17 respondents gave their proposals in the freely worded response field. Their opinions of a suitable duration varied from 15 minutes to 2 hours. A longer duration at night was suggested, as fewer persons giving warnings are on the road at night.

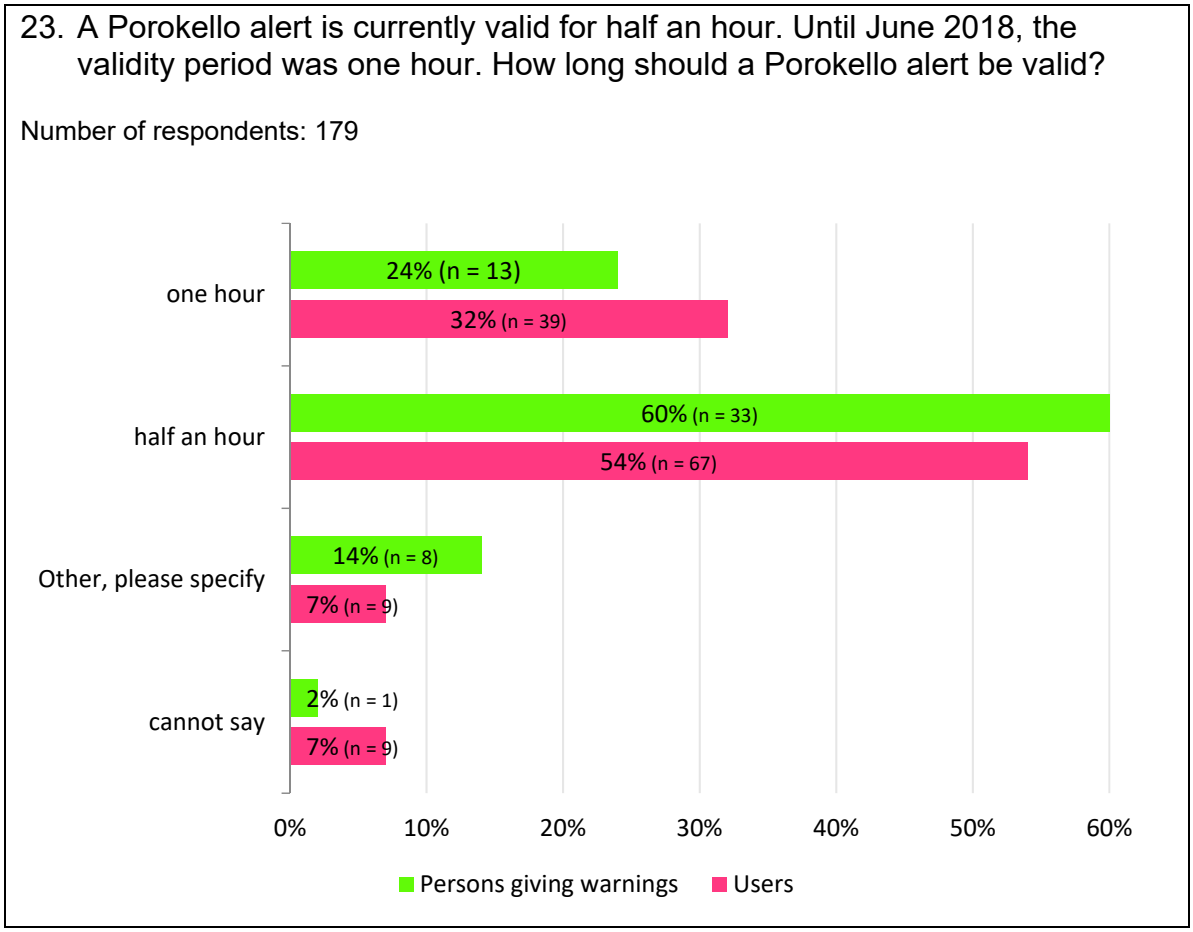


Figure 42. How long should a Porokello alert be valid? Survey results, combined results of persons giving warnings and users.

The majority accepted the idea of all registered drivers being able to give warnings. 69% of persons giving warnings and 62% of users felt this was the best option among those presented (Figure 43).

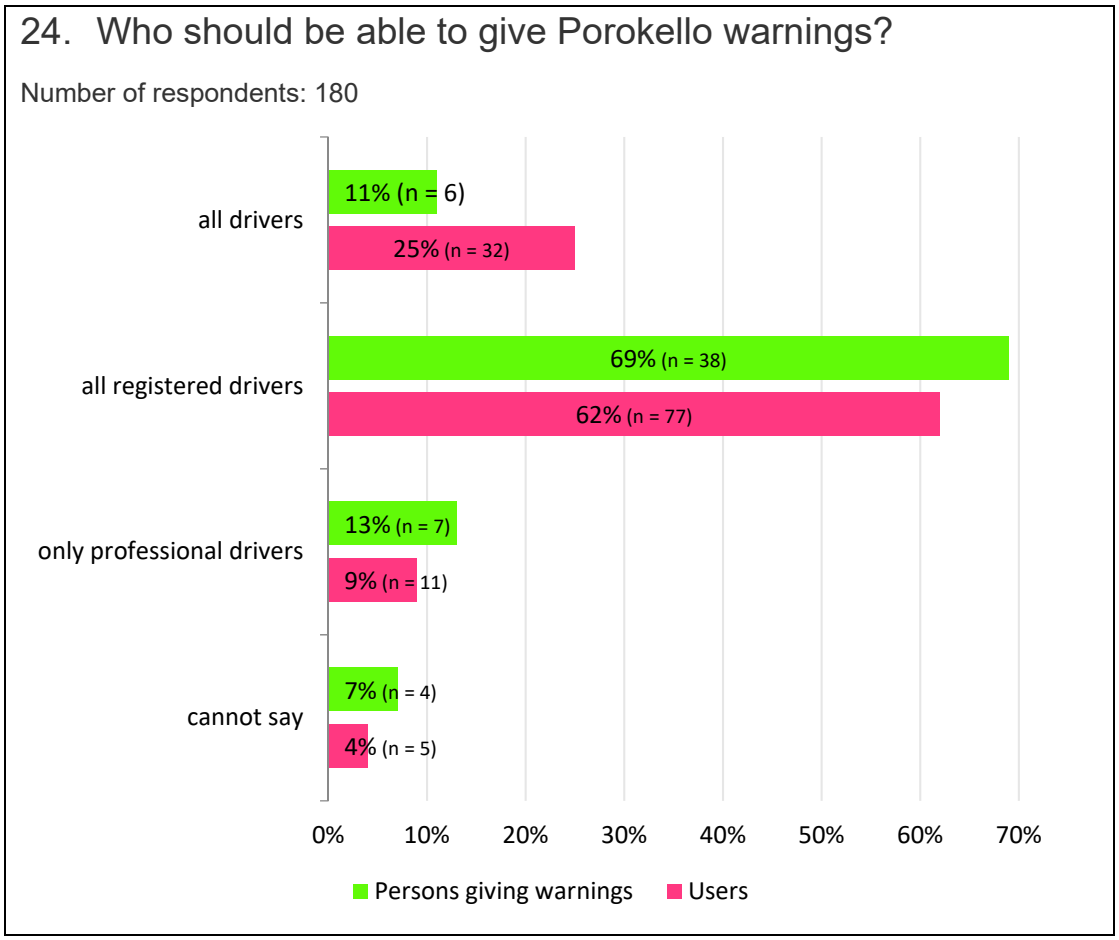


Figure 43. Who should be able to give Porokello warnings? Survey results, combined results of persons giving warnings and users.

When asked about areas where the number of persons giving warnings is not sufficient, the respondents listed more than 80 roads or areas. These roads and areas are located in different parts of the reindeer husbandry area. The areas of Rovaniemi, Sodankylä, Pudasjärvi, Ranua, Lohiniva, Savukoski, Sevettijärvi, Salla and Inari were cited in several responses. In addition, smaller back roads were mentioned in many responses.

These roads corresponded to a great extent to the road sections with high collision densities or high accident rates found in the map analyses. On the other hand, the survey highlighted certain individual areas, for example Savukoski and Sevettijärvi, where only individual road sections with high collision densities were found in the map analysis. They were thus not included in the worst areas in the map analysis.

Advantages and disadvantages of the Porokello alert system

Responses to the question about Porokello's advantages were received from 36 persons giving warnings and 84 users. Freely worded responses about the disadvantages of the system were received from 34 persons giving warnings and 78 users.

A summarised list of the advantages and disadvantages cited by the respondents is given below. The number of responses is given in brackets if several respondents gave the same suggestion. The same respondent could list several advantages or disadvantages.

Advantages of the Porokello alert system (persons giving warnings and users):

- increases alertness (41)
- reduces reindeer collisions (21)
- helps reduce the number of hazardous situations (16)
- improves traffic safety (10)
- improves the safety of reindeer (2)
- clear and easy to use (17)
- simple and well-functioning user interface/app (11)
- a good and necessary app idea (11)
- a good aid on the road
- good visibility, does not distract the driver
- has the effect of reducing driving speeds
- possibility of displaying a map of the entire reindeer husbandry area
- the map on which you can see the alerts on your route in advance helps you estimate the driving time compared to normal circumstances
- it is great to be able to warn other drivers, but I continue to flash my lights
- merely advertising the app makes road users drive more carefully and spreads awareness of reindeer
- Preventing reindeer collisions may foster positive attitudes towards reindeer husbandry. Extremely good for those who drive in unfamiliar parts of the reindeer husbandry area, and especially for incidental drivers from outside this area.
- Works well especially for those who are not used to reindeer; personally I keep an equally careful lookout, whether the app is on or not.

Disadvantages of the Porokello alert system (persons giving warnings and users):

- geographical or temporal gaps in alerts, too few persons giving warnings (37)
- the app is heavy on the battery (13)
- unnecessary alerts (no reindeer in sight) (9)
- would like to give warnings themselves/expand the right to give warnings (8 users)
- the alert signal is difficult to hear (5)
- the validity period of the alert is too short (5)
- does not work, unreliable (4)
- problems with turning the app on/off (3)
- gives a false feeling of safety (2)
- the reindeer have time to move away from the area concerned (2)
- accuracy (2)
- does not reach the correct target group (tourists and others who are not used to driving in the reindeer husbandry area) (2)
- not all vehicles can receive alerts
- excessive reliance on the app may result in careless if you do not otherwise stay alert
- sometimes the alert comes too late, or when I have already passed the reindeer
- foreigners cannot download the app.

The persons giving warnings also cited the following disadvantages associated with their apps:

- When using Bluetooth devices, for example when playing music or talking on the phone, the alert cannot be heard or seen on the phone; more Porokello alert sounds (2).
- Difficult to know if the Porokello alert was sent or not – a clear acknowledgement/sound should be given. (5)
- The Varottaja app must always be kept on top (3). The app should have a push-button or some other way of activating it so that I could also use other apps. The app could be activated and pop up on top in a reindeer alert area, otherwise it could stay in the background.
- The phone does not always sound an alert. (3)
- Better guidelines should be provided on when to give a warning: only when you see reindeer on the side of the road, or also when you see them in a field; should a warning be repeated. (2)
- If you have forgotten to turn the Porokello app on, there is a small delay in giving a warning as the GPS search is slow. (2) Additionally, if you turn the Varottaja app on suddenly, it puts the warning in a queue until you give the following warning.
- The app can easily be turned off accidentally, for instance if you go to another app.
- Sometimes the connection is bad and the app turns itself off.
- The map and the alerts on it cannot be seen in the Varottaja app. You need to have the Porokello app separately.

Developing Porokello

Responses to the question about which of Porokello's features should be developed and how were received from 21 persons giving warnings and 72 users. The suggestions given by the respondents are listed below. The number of responses is given in brackets if several respondents gave the same suggestion.

Persons giving warnings

- A sound or some other indicator of a warning having been received. (2)
- Porokello events [could be organised] in other places besides Rovaniemi.
- There should be a button you could press to cancel a reindeer warning you have given, for example if you pressed the button by accident. And you should be able to cancel reindeer alerts given by others, for instance if the reindeer are no longer there. It should also be possible to adjust the distance covered by the alert. For a lorry, for example, the alert sometimes comes too late.
- The alerts should be visible on the map whenever the app is on. In that case, the warning button could be smaller.
- The power consumption of the phone should be reduced.
- There should be a different alert for situations where a large number of reindeer are on the road, or where a single reindeer is e.g. running away from insects. In other words, the alerts should have some kind of 'scale of severity'.
- Instructing car hire companies to download the app for their foreign customers, and of course clear instructions also for Finnish customers (a brochure to hand out).
- More visible marketing at hotels and airports, on the roadside, at inspection stations and petrol stations, and in local news. Local papers in the reindeer husbandry area should have articles about Porokello and its benefits. Rovaniemi snowmobile fair should have a stand for marketing Porokello.
- Turning on the Varottaja app should be made more flexible.
- A Varottaja network should be created.
- Reindeer herders should be able to put longer-lasting alerts in place in high-risk areas, and reindeer herders should be giving warnings.
- Voice commands for giving warnings.
- A special device for all persons giving warnings.
- An alert for areas where a high number of collisions tend to happen. Would help at those times when few persons giving warnings are on the road.

Users

- The number of persons giving warnings should be increased (as options were cited reindeer herders, Porokello users, all those who register specifically, all drivers). (32)

- More information should be available on how Porokello works (including the fact that the alert is not based on positioning the reindeer).
- The app should be faster and easier to turn on/off. (2)
- It should be possible to show high-risk areas permanently on the map as a so-called increased risk zone. Reindeer have favoured the same areas for decades.
- The alerts are only based on visual observations. Could this app be used in existing GPS devices on reindeer?
- After half an hour, the alert could become a less urgent, silent alert.
- Porokello is good, but basing the alerts on the actual reindeer would improve their coverage.
- Areas with on-going reindeer herding work should be marked somehow on the map, e.g. with a different colour.
- The alert signals should be slightly louder.
- Permission to use location and a prompt to turn the app on when the driver enters the relevant area.
- The app would be really helpful if the alert locations were analysed and locations where reindeer collisions have occurred were also marked (a bit like the elk risk areas). For this could be used a yellow tape half a metre in length, which would be tied to the reflective posts on the side of the road. The high-vis colour would wake up the driver and could maybe also make the reindeer avoid this spot.

Receiving alerts, users

Users were also asked what effects situations where they received an alert but did not see reindeer in the relevant area had on them (e.g. reliability, pleasantness, frustration). 57 responses were received:

- None at all, the animals will move! I think the reindeer have moved further into the woods. (32)
- Affects reliability. (10)
- It is a good thing. A good reminder, keeps you alert. (5)
- Frustrating. (6)
- Mainly frustrating, but it would be better to have more rather than less alerts.
- Depends on the area. Receiving an alert in town seems weird, but out in rural areas it is ok.
- The alerts are something positive.
- In my case, it is the opposite: I have seen reindeer but rarely received alerts, which perhaps erodes my confidence more than unnecessary reindeer alerts.

Conclusions

Based on the results of the Internet surveys and workshops we can conclude that, according to driver experiences, Porokello alerts improve safety, both regarding reindeer collisions and general traffic safety. More than 90% of those who responded to the survey said the alert had helped them focus their attention and affected their driving speed. Some two out of three persons giving warnings and users felt they had avoided a collision thanks to an alert.

As in a previous study of a reindeer alert service (Aittoniemi et al 2015), as the most important impacts on driving behaviour emerged effects on focusing the driver's attention. In Porokello trial, impacts on driving speeds and overtaking behaviour were cited in a significantly greater share of responses than in a previous trial of a reindeer alert service.

When persons giving warnings were asked how often the driver had already received an alert when encountering a reindeer, more than one half of the respondents said that they had received an alert before 40% of the encounters. This indicates that the network of persons giving warnings does not yet have sufficient coverage.

When users of the Porokello app were asked about the impacts of situations where they had received an alert but did not see any reindeer in the relevant area, more than one out of two respondents said they thought the reindeer had moved out of sight. One out of six, however, felt that this affected their perception of the system’s reliability.

To measure the acceptability of Porokello, the same metrics were used as in a previous study (Aittoniemi et al. 2015). The results of the survey were similar to the findings of the earlier study. Compared to the previous study, satisfaction with the reliability and timing of the alerts was at a slightly higher level. Satisfaction with the comprehensibility of the alert, visibility of an incoming alert and the giving of warnings was slightly lower than in the previous study. The level of satisfaction with the usefulness of the alerts was higher among persons giving warnings than in the previous study.

As another indicator for the acceptability of the service, the Van der Laan scale was used. Based on this indicator, too, the results of the survey were similar to the results of a previous study. Porokello was found even more useful by persons giving warnings than in the previous study. The respondents were relatively satisfied with Porokello, as they were with the reindeer alert system in the previous study, however this indicator showed a slightly lower level of satisfaction with Porokello.

While more than one half of the respondents found the current period of validity, or half an hour, appropriate, a longer duration at night was suggested, as fewer persons giving warnings are on the roads at night. The Porokello app could also warn users when they reach an area with a high collision risk, for example using an high-vis colour.

The majority accepted the idea of all drivers giving warnings if registration were required.

6 Conclusions

On the basis of examination of statistics and maps, it can be seen that the number of reindeer accidents and the reindeer accident rate (accidents/vehicle kilometres driven) have decreased since the introduction of Porokello from 2017 to 2018 compared with the averages for the comparison period 2011 to 2015.

The accident rates for 2017 to 2018 were over 30% lower on the stretches of road that had the worst accident rates from 2011 to 2015. A lot of alerts have been given on these stretches of road relative to the volume of traffic. The alerts are likely to be one factor in the positive development of safety.

The stretches of road were the accident density is greatest, i.e. where most accidents have occurred, carry high volumes of traffic. Over half (65%) of the alerts have been given on these stretches of road. The safety improvements on these stretches of road from the period 2011 to 2015 to the period 2017 to 2018 have been better than average.

On stretches of road where the accident densities or accident rates were low from 2011 to 2015, accident densities and rates have decreased by less than average or have increased. Significantly fewer alerts have been given on these stretches of road than on those where the accident densities and rates are higher.

On the basis of examination of stretches of road and correlation analysis there is no direct link between the number of people giving warnings and the number of alerts, and the changes in the number of reindeer collisions and the accident rate. This is probably because there is no data about changes in the number of reindeer moving on stretches of road and so it has not been possible to take this into account in the analysis.

Data about the number of road users receiving alerts through the Porokello application on specific stretches of road was not available to the study. One possible explanation for the lack of correlation between the number of people giving warnings and the number of alerts, and the change in the accident rate in the statistical analysis, could be that the number of drivers receiving reindeer alerts accounts for a low proportion of all road users.

It is probable that the positive change in reindeer accidents is due to the impact of the Porokello service, but in this study it has not been possible to differentiate between the impact of Porokello and the effect of other factors just on the basis of two years' experience and the data available. The conditions for a statistical evaluation of the impact of the Porokello service will clearly be better in a few years' time than at present, when collision data and data about warnings given as well as about alerts received, and data about the applications used by those people using the alerts, will be available over a longer time period. The study also identified a need to add data to the collision data recorded in the ePoro database as to whether it has been possible to the verify the location of the collision on the ground.

In online surveys, approximately 9 out of 10 drivers said they had taken precautions and changed their driving habits after receiving a reindeer alert. The biggest reported impact on driving style was the increase in alertness and reduction of driving speed. The responses received support the notion that the alerts have an

impact on reindeer collisions and general traffic safety. According to the experiences of those who took part in the workshops as well, the alerts have had a concrete benefit both through the increase in watchfulness resulting from the alerts and also through the savings in fuel costs for heavy vehicles for example.

With the aid of the workshops and the maps produced during the study, areas or routes have been identified where the number of people giving warnings needs to be increased. On the basis of the statistics and the maps, more people giving warnings in traffic are needed at least during late afternoon, in the evenings, weekends and during holiday periods when there are fewer alerts in relation to the number of collisions than at other times.

The impact of the warnings is affected by the coverage of the alerts with regard to location areas and timing, and also by the number of road users that receive the reindeer alerts. At the moment, the relative proportion of users of the service compared to the daily number of road users is still low. Because of this it is not possible to decide what level of increase in the number of people giving warnings is needed. The workshops and surveys have identified that the alerts have to be reliable, so a condition for giving a warning should continue to be a least registering with the service. Increasing the number of people giving warnings and increasing the number of alerts could weaken the impact of the service, or even reduce people's use of the service, if road users felt that continuous alerts were becoming frustrating. This however could be addressed by developing the functioning of the service and the application, for example by changing the duration of an alert and the area it covers, and giving an indication of alerts received.

In the course of a year, professional drivers accumulate a lot of kilometres so their input as providers of reindeer warnings is very important for the service, and so they should be encouraged to become active users of the service.

It is recommended that the Porokello application be further developed and actively marketed in the future to increase the number of users receiving alerts and thereby increase the effectiveness of the alerts. Since heavy vehicles are relatively often involved in collisions with reindeer, the use of the Porokello application should be promoted more among drivers of heavy vehicles as well.

7 References

7.1 Written references

Aittoniemi, E. & Rämä, P. & Penttinen, M. (2015). Ajantasaisen porovaroituspalvelun hyväksyttävyys ja vaikutukset – ammattikuljettajien kenttätutkimus poronhoitoalueella. (Acceptability and impact of real time reindeer alert service - field research on professional drivers in reindeer husbandry area.) Trafin tutkimuksia 17/2015.

Ilmatieteen laitos 2019. https://ilmatieteenlaitos.fi/talvitilanne . Referred to in March 2019.

Kinnunen, T. & Simonen, M. (2011). Porokolarit ja niiden vähentäminen. (Reindeer collisions and reducing them.) ELY Centre for Lapland.

Finnish Road Safety Council 2019. Publication Poro liikenteessä (Reindeer and traffic). Saatavissa https://www.liikenneturva.fi/sites/default/files/materiaalit/Liikenteessa/poro_liikenteessae_id_3430_id_14252.pdf . Referred to in January 2019.

Molkoselkä, P. & Palo, K. (2016). Ympäristötekijöiden vaikutus porokolarien esiintymiseen valtatien 20 alueella. Lapland University of Applied Sciences thesis.

Nieminen, M. (2012). Porojen liikennekuolemat vuosina 2005 – 2011 – Pahimmat kolaripaliskunnat ja tieosuudet. Working reports of the Finnish Game and Fisheries Research Institute 5/2012.

Ollila, A. 2018. Poromies journal 5/2018. Editorial ”Poro liikenteessä”.

Paliskuntain yhdistys 2019a. paliskunnat.fi . Referred to in January 2019.

Reindeer Herders’ Association 2019b. Publication Poro. Saatavissa https://paliskunnat.fi/poro/wp-content/uploads/2015/05/poro_suomi_web.pdf . Referred to in March 2019.

Porokello 2019. https://porokello.fi/ . Referred to in March 2019.

Timo-Huhtala, M. (2018). Porokello – porovaroittaminen liikenteessä älyteknologia avulla, loppuraportti 2016 – 2017. (Porokello - reindeer alerts in traffic using smart technology, final report 2016 - 2017). ELY Centre for Lapland reports 4/2018.

Turpeenniemi, J. (2017). Porokello-hankkeen jatkuvuus. (Continuity of the Porokello project.) Lapland University of Applied Sciences thesis.

Van der Laan, J.D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. Transportation Research - Part C: Emerging Technologies, 5, 1-10.

7.2 Interviews and correspondence

Heiskari, V. 2018. Poikajärvi reindeer herders’ cooperative, road traffic accident damage assessor. Interview 28 November 2018

Kotila, H. 2018. Palojärvi reindeer herders' cooperative, road traffic accident damage assessor. Interview 28 November 2018

Maununiemi, A. 2018. Owner of Sierijärvi reindeer farm. Interview 28 November 2018

Rajamäki R. 2019. About reindeer collisions E-mail message 21 March 2019.

Särkelä, M. 2019. Comments on draft report and e-mail exchanges in March 2019.

Questionnaire
PERSONS
GIVING
WARNINGS

Tutkimus Porokellon vaikutuksista

Osa 1 - Taustakysymykset

Ikäsi?

- ◯ 18-30
- ◯ 31-40
- ◯ 41-50
- ◯ 51-60
- ◯ 60-

Omistatko itse tai omistaako läheisesi poroja?

- ◯ kyllä
- ◯ ei

Millä tiellä tai alueella yleensä liikut?

_____
_____
_____
_____
_____

Oletko ammattiautoilija? (raskas ajoneuvo, taksi, linja-auto, hälytysajoneuvo)

- ◯ kyllä
- ◯ ei

Mikä on ammattisi?

- ☐ raskaan ajoneuvon kuljettaja
- ☐ taksinkuljettaja
- ☐ linja-auton kuljettaja
- ☐ hälytysajoneuvon kuljettaja/apukuljettaja
- ☐ muu, mikä _____

Kuinka kauan olet ollut ammattiautoilija?

- ◯ alle vuoden
- ◯ 1-5 vuotta
- ◯ 6-10 vuotta
- ◯ yli 10 vuotta

Kuinka paljon keskimäärin ajat työajoa vuodessa?

- ◯ alle 20 000 km
- ◯ 20 000 – 50 000 km
- ◯ 50 000 - 100 000 km
- ◯ yli 100 000 km

Kuinka paljon keskimäärin ajat yksityisajoa henkilöautolla vuodessa?

- ◯ alle 10 000 km
- ◯ 10 000 – 30 000 km
- ◯ yli 30 000 km

Paljonko ajat keskimäärin vuodessa?

- ◯ alle 10 000 km
- ◯ 10 000 – 30 000 km
- ◯ 30 000 - 50 000 km
- ◯ yli 50 000 km

Onko käytössäsi (voit vastata useamman)

- ☐ PorokelloPro-sovellus (erillinen varoituspuhelin)
- ☐ Porokello Varottaja -sovellus (omassa älypuhelimessa)
- ☐ Porokello-sovellus (vain varoitusten vastaanotto)

Koska aloit antaa varoituksia Porokello-käyttäjänä?

- ◯ heinäkuu-joulukuu 2016
- ◯ tammikuu-kesäkuu 2017
- ◯ heinäkuu-joulukuu 2017
- ◯ tammikuu-kesäkuu 2018
- ◯ heinäkuu-joulukuu 2018

Kuinka iso osa porokohtaamisistasi on ollut sellaisia, että olet saanut varoituksen? Ajattele vuotta 2018.

- ◯ 0-20%
- ◯ 20-40%
- ◯ 40-60%
- ◯ 60-80%
- ◯ 80-100%

Mitkä ovat päämotiivisi toimia Porokello-varoittajana? Valitse kolme tärkeintä.

- ☐ työnantaja velvoittaa
- ☐ haluan edistää liikenneturvallisuutta
- ☐ haluan vähentää porokolareita
- ☐ haluan varoittaa muita tiellä liikkujia
- ☐ haluan välttää porokolareista aiheutuvia haittoja ja kustannuksia
- ☐ minulla on henkilökohtainen halu toimia porovaroittajana
- ☐ haluan olla kehittämässä uutta teknologiaa
- ☐ joku muu, mikä _____

Kuinka isolla osalla matkoistasi porohoitoalueella Porokello on päällä?

- ◯ lähes aina
- ◯ noin puolella matkoista
- ◯ harvemmin

Milloin pidät Porokelloa päällä ajaessasi poronhoitoalueella?

- ◯ aina
- ◯ satunnaisesti
- ◯ vain vieraassa ympäristössä
- ◯ huonolla kelillä
- ◯ sellaiseen aikaan, kun oletan kolarivaaran olevan suuri

Koska annoit viimeksi varoituksen?

- ◯ viimeisen vuorokauden aikana
- ◯ viimeisen viikon aikana
- ◯ viimeisen kuukauden aikana
- ◯ yli kuukausi sitten

Annatko uuden varoituksen, jos näet poron kohdassa, jossa on jo varoitus voimassa?

- ◯ kyllä
- ◯ en

Oletko ollut porokolarissa? *

- ◯ kerran
- ◯ 2 kertaa
- ◯ useammin
- ◯ en

Kolari 1 (viimeisin porokolarisi)

Milloin kolari tapahtui? (vuosi, kuukausi, kellonaika)

vuosi	kuukausi	

Oliko käytössäsi Porokello?

- ◯ kyllä
- ◯ kyllä, mutta ei päällä
- ◯ ei

Saitko varoituksen?

- ◯ kyllä
- ◯ en

Kolari 2 (viimeistä edellinen porokolarisi)

Milloin kolari tapahtui? (vuosi, kuukausi, kellonaika)

vuosi	kuukausi	

Oliko käytössäsi Porokello?

- ◯ kyllä
- ◯ kyllä, mutta ei päällä
- ◯ ei

Saitko varoituksen?

- ◯ kyllä
- ◯ en

Oletko mahdollisesti välttänyt kolarin varoituksen ansiosta?

- ◯ kyllä, useasti
- ◯ kyllä, ainakin kerran
- ◯ en

Osa 2 - Varoituksen saaminen

Muistele viimeisintä tapahtumaa, kun sait varoituksen Porokellolla. Milloin tämä tapahtui, näitkö poroja? Vastaa seuraaviin kysymyksiin kyseisen tapahtuman perusteella.

Tapahtuman aika ja paikka: (mahdollisimman tarkasti)

Havaitsin poroja varoitusalueella

- ◯ kyllä
- ◯ en

Varoitusalueella porot olivat

- ☐ ajoradalla
- ☐ penkereellä
- ☐ kauempana tiestä

Olisin havainnut porot myös ilman varoitusta

- ◯ kyllä
- ◯ en

Havaitsin porot aikaisemmin kuin ilman varoitusta olisin tehnyt

- ◯ kyllä
- ◯ en

Varauduin tai muutin ajotapaani varoituksen takia

- ◯ kyllä
- ◯ en

Vältin kolarin varoituksen takia

- ◯ kyllä
- ◯ en

Miten porovaroitus vaikutti käyttäytymiseesi? Ajattele koko ajan nimenomaan varoituksen vaikutusta, eli vertaa tilannetta ennen kuin sait varoituksen tilanteeseen saatuasi varoituksen.

AJONOPEUS

Miten varoitus vaikutti ajonopeuteesi?

- ☐ ei mitenkään
- ☐ hiljensin nopeutta varoituksen saatuani varoitusalueella
- ☐ hiljensin nopeutta vasta, kun itse näin poron
- ☐ ajoin hitaammin loppumatkan
- ☐ muuten, miten? _____
- ☐ en osaa sanoa

SEURAAMISETÄISYYS

Miten varoitus vaikutti etäisyyteesi edellä ajavaan?

- ◯ ei mitenkään
- ◯ pidin pidemmän välin
- ◯ pidin pidemmän välin vasta, kun itse näin poron
- ◯ muuten, miten? _____
- ◯ en osaa sanoa

OHITTAMINEN

Miten varoitus vaikutti ohituskäyttäytymiseesi?

- ☐ ei mitenkään
- ☐ ohitin varovaisemmin
- ☐ ohitin harvemmin
- ☐ pyrin välttämään ohituksia kokonaan
- ☐ vasta poron näkeminen vaikutti ohittamiseen
- ☐ muuten, miten? _____
- ☐ en osaa sanoa

HALLINTALAITTEIDEN KÄYTTÖ

Miten varoitus vaikutti hallintalaitteiden (ohjauspyörä, polkimet, vaihteet, muut säätölaitteet) käyttöösi?

- ☐ ei mitenkään
- ☐ auton ohjaamiseen, miten? _____
- ☐ kaasupolkimen käyttöön, miten? _____
- ☐ jarrupolkimen käyttöön, miten? _____
- ☐ kytkimen käyttöön, miten? _____
- ☐ vaihteiden käyttöön, miten? _____
- ☐ vasta poron näkeminen vaikutti hallintalaitteiden käyttöön
- ☐ muuten, miten? _____
- ☐ en osaa sanoa

AJAMISEN OHESSA TEHTÄVÄT TOIMINNAT

Miten varoitus vaikutti ajamisen ohessa tekemiisi toimintoihin?

- ☐ ei mitenkään
- ☐ radion käyttöön, miten? _____
- ☐ matkapuhelimen käyttöön, miten? _____
- ☐ muiden ajoneuvossa olevien laitteiden käyttöön, miten? _____
- ☐ keskusteluun kanssamatkustajien kanssa, miten? _____
- ☐ vasta porojen näkeminen vaikutti oheistoimintoihin
- ☐ muuten, miten? _____
- ☐ en osaa sanoa

VAROITUKSESTA KESKUSTELU

Jos mukanasi oli matkustaja, keskustelitteko varoituksesta sen saatuanne?

- ☐ Kyllä, keskustelimme varoituksen tarkoituksesta.
- ☐ Kyllä, mietimme, mitä pitäisi tehdä.
- ☐ Keskustelimme varoituksesta vasta, kun näimme poron.
- ☐ Ei keskusteltu.
- ☐ Ei, ajoin yksin.
- ☐ Muuta, mitä? _____

TARKKAAVAISUUDEN SUUNTAAMINEN

Miten varoitus vaikutti tarkkaavaisuutesi suuntaamiseen (mitä tietoa haet liikenneympäristöstä)?

- ☐ ei mitenkään
- ☐ seurasin enemmän tienpientareita mahdollisten porojen ja muiden eläinten takia
- ☐ keskityin enemmän omaan ajamiseen
- ☐ seurasin enemmän henkilö- ja pakettiautojen käyttäytymistä
- ☐ seurasin enemmän toisten kuorma-, linja- ja rekka-autojen käyttäytymistä
- ☐ seurasin enemmän takana tulevaa liikennettä
- ☐ seurasin enemmän edellä ajavaa ajoneuvoa
- ☐ seurasin enemmän vastaantulevaa liikennettä
- ☐ seurasin enemmän jalankulkijoiden ja polkupyöräilijöiden käyttäytymistä
- ☐ kiinnitin huomiota ajokeliin
- ☐ tarkkaavaisuuteni lisääntyi vasta, kun näin poron
- ☐ muuten, miten? _____
- ☐ en osaa sanoa

MUU VAIKUTTAMINEN

Vaikuttiko varoituksen saaminen muulla tavoin?

- ◯ kyllä, miten? _____
- ◯ ei
- ◯ en osaa sanoa

Osa 3 – Porokelloon liittyvät yleiset kysymykset

Kuinka tyytyväinen olet Porokellon toimintaan? Osoita mielipiteesi mitta-asteikolla, valitse yksi vastaus riviä kohti.

	Erittäin tyytyväinen	Melko tyytyväinen	En tyytyväinen enkä tyytymätön	Melko tyytymätön	Erittäin tyytymätön
Varoituksen ymmärrettävyys	◯	◯	◯	◯	◯
Varoituksen luotettavuus	◯	◯	◯	◯	◯
Varoituksen ajoitus	◯	◯	◯	◯	◯
Varoituksen hyödyllisyys	◯	◯	◯	◯	◯
Saapuvan varoituksen huomaaminen	◯	◯	◯	◯	◯
Varoituksen antaminen	◯	◯	◯	◯	◯

Kuinka kuvaisit Porokelloa kokemuksiesi perusteella? Osoita mielipiteesi mitta-asteikolla, valitse yksi vastaus riviä kohti.

	1	2	3	4	5	
Hyödyllinen	◯	◯	◯	◯	◯	Hyödytön
Miellyttävä	◯	◯	◯	◯	◯	Epämiellyttävä
Huono	◯	◯	◯	◯	◯	Hyvä
Tarpeet tyydyttävä	◯	◯	◯	◯	◯	Pettymys
Tehokas	◯	◯	◯	◯	◯	Tehoton
Ärsyttävä	◯	◯	◯	◯	◯	Miellyttävä
Avustava	◯	◯	◯	◯	◯	Häiritsevä
Epämieluisa	◯	◯	◯	◯	◯	Mieluisa
Vireyttä lisäävä	◯	◯	◯	◯	◯	Unettava

Kyselyn yhtenä tarkoituksena on hakea tietoa siitä, puuttuuko varoittajia joiltakin alueilta. Onko joitakin tieosuuksia, joissa olet usein havainnut poroja, mutta et ole saanut varoitusta?

- ◯ kyllä, missä? _____
- ◯ ei

Porokellon varoitus on nykyään voimassa puoli tuntia sen antohetkestä. Kesäkuun 2018 loppuun asti varoitus oli päällä tunnin. Kuinka pitkäkestoisia varoitusten pitäisi sinun mielestäsi olla?

- ◯ tunti
- ◯ puoli tuntia
- ◯ muu, mikä? _____
- ◯ en osaa sanoa

Keiden tulisi mielestäsi voida toimia Porokello-varoittajana

- ◯ kaikki autoilijat
- ◯ kaikki autoilijat, mutta erikseen rekisteröityneenä
- ◯ vain ammattiautoilijat
- ◯ en osaa sanoa

Mitkä ovat mielestäsi Porokellon hyvät puolet?

Mitkä ovat mielestäsi Porokellon huonot puolet?

Mitä Porokellon ominaisuuksia pitäisi mielestäsi kehittää ja miten?

Miltä ajaminen Porokellon kanssa tuntuu? Jos haluat vielä kommentoida Porokelloa tai kyselyä, sana on vapaa!

Questionnaire
USERS

Appendix 2

Tutkimus Porokellon vaikutuksista

Osa 1 - Taustakysymykset

Ikäsi?

- ◯ 18-30
- ◯ 31-40
- ◯ 41-50
- ◯ 51-60
- ◯ 60-

Kuinka usein ajat poronhoitoalueella?

- ◯ asun poronhoitoalueella
- ◯ en asu poronhoitoalueella, mutta käyn alueella säännöllisesti
- ◯ käyn alueella satunnaisesti

Omistatko itse tai omistaako läheisesi poroja?

- ◯ kyllä
- ◯ ei

Millä tiellä tai alueella yleensä liikut?

_____

_____

_____

Paljonko ajat keskimäärin vuodessa?

- ◯ alle 10 000 km
- ◯ 10 000 - 30 000 km
- ◯ 30 000 - 50 000 km
- ◯ yli 50 000 km

Kuinka paljon ajat Porokellon kanssa poronhoitoalueella vuodessa?

- ◯ alle 1 000 km
- ◯ 1 000 - 5 000 km
- ◯ 5 000 - 10 000 km
- ◯ 10 000 – 30 000 km
- ◯ yli 30 000 km

Koska otit Porokello-sovelluksen käyttöön?

- ◯ syyskuu-joulukuu 2017
- ◯ tammikuu-kesäkuu 2018
- ◯ heinäkuu-joulukuu 2018

Käytätkö sovellusta

- ◯ päivittäin
- ◯ viikoittain
- ◯ kuukausittain
- ◯ harvemmin

Milloin pidät Porokelloa päällä ajaessasi poronhoitoalueella?

- ◯ aina
- ◯ satunnaisesti
- ◯ vain vieraassa ympäristössä
- ◯ huonolla kelillä
- ◯ sellaiseen aikaan, kun oletan kolarivaaran olevan suuri

Oletko ollut porokolarissa? *

- ◯ kerran
- ◯ 2 kertaa
- ◯ useammin
- ◯ en

Kolari 1 (viimeisin porokolarisi)

Milloin kolari tapahtui? (vuosi, kuukausi, kellonaika)

vuosi	kuukausi	

Oliko käytössäsi Porokello?

- ◯ kyllä
- ◯ kyllä, mutta ei päällä
- ◯ ei

Saitko varoituksen?

- ◯ kyllä
- ◯ en

Kolari 2 (viimeistä edellinen porokolarisi)

Milloin kolari tapahtui? (vuosi, kuukausi, kellonaika)

vuosi	kuukausi	

Oliko käytössäsi Porokello?

- ◯ kyllä
- ◯ kyllä, mutta ei päällä
- ◯ ei

Saitko varoituksen?

- ◯ kyllä
- ◯ en

Oletko mahdollisesti välttänyt kolarin varoituksen ansiosta?

- ◯ kyllä, useasti
- ◯ kyllä, ainakin kerran
- ◯ en

Kun näet varoitusalueella poron, onko tällä lisävaikutusta ajokäyttäytymiseesi?

- ◯ Porokello-varoitus vaikuttaa ajokäyttäytymiseeni, mutta poron näkeminen vahvistaa vaikutusta.
- ◯ Vasta poron näkeminen saa minut muuttamaan ajokäyttäytymistäni.
- ◯ Poron näkeminen vaikuttaa ajokäyttäytymiseeni vain, jos poro käyttäytyy niin, että vaikuttaa, että poro on tulossa ajoradalle.
- ◯ Ei, poron näkemisellä ei ole lisävaikutusta ajokäyttäytymiseeni.

Vaikuttaako Porokellon olemassaolo porojen tarkkailemiseen yleensä (hetkinä jolloin varoitusta ei ole voimassa)?

- ◯ Kyllä, tarkkailen enemmän näkyykö tien varrella poroja.
- ◯ Kyllä, tarkkailen vähemmän näkyykö tien varrella poroja.
- ◯ Ei vaikuta.
- ◯ En osaa sanoa.

Osa 2 – Varoituksen saaminen

Muistele viimeisintä tapahtumaa, kun sait varoituksen Porokellolla. Milloin tämä tapahtui, näitkö poroja? Vastaa seuraaviin kysymyksiin kyseisen tapahtuman perusteella.

Tapahtuman aika ja paikka: (mahdollisimman tarkasti)

_____

_____

_____

_____

_____

Havaitsin poroja varoitusalueella

- ◯ kyllä
- ◯ en

Varoitusalueella porot olivat

- [ ] ajoradalla
- [ ] penkereellä
- [ ] kauampana tiestä

Olisin havainnut porot myös ilman varoitusta

- ◯ kyllä
- ◯ en

Havaitsin varoituksen takia porot aikaisemmin kuin ilman varoitusta olisin tehnyt

- ◯ kyllä
- ◯ en

Varauduin ja muutin ajotapaani varoituksen takia

- ◯ kyllä
- ◯ en

Vältin kolarin varoituksen takia

- ◯ kyllä
- ◯ en

Miten porovaroitus vaikutti käyttäytymiseesi? Ajattele koko ajan nimenomaan varoituksen vaikutusta, eli vertaa tilannetta ennen kuin sait varoituksen tilanteeseen saatuasi varoituksen.

AJONOPEUS

Miten varoitus vaikutti ajonopeuteesi?

- [ ] ei mitenkään
- [ ] hiljensin nopeutta varoituksen saatuani varoitusalueella
- [ ] hiljensin nopeutta vasta, kun itse näin poron
- [ ] ajoin hitaammin loppumatkan
- [ ] muuten, miten? _____
- [ ] en osaa sanoa

SEURAAMISETÄISYYS

Miten varoitus vaikutti etäisyyteesi edellä ajavaan?

- ◯ ei mitenkään
- ◯ pidin pidemmän välin
- ◯ pidin pidemmän välin vasta, kun itse näin poron
- ◯ muuten, miten? _____
- ◯ en osaa sanoa

OHITTAMINEN

Miten varoitus vaikutti ohittamiskäyttäytymiseesi?

- [ ] ei mitenkään
- [ ] ohitin varovaisemmin
- [ ] ohitin harvemmin
- [ ] pyrin välttämään ohituksia kokonaan
- [ ] vasta poron näkeminen vaikutti ohittamiseen
- [ ] muuten, miten? _____
- [ ] en osaa sanoa

HALLINTALAITTEIDEN KÄYTTÖ

Miten varoitus vaikutti hallintalaitteiden (ohjauspyörä, polkimet, vaihteet, muut säätölaitteet) käyttöösi?

- [ ] ei mitenkään
- [ ] auton ohjaamiseen, miten? _____
- [ ] kaasupolkimen käyttöön, miten? _____
- [ ] jarrupolkimen käyttöön, miten? _____
- [ ] kytkimen käyttöön, miten? _____
- [ ] vaihteiden käyttöön, miten? _____
- [ ] muuten, miten? _____
- [ ] vasta poron näkeminen vaikutti hallintalaitteiden käyttöön
- [ ] en osaa sanoa

AJAMISEN OHESSA TEHTÄVÄT TOIMINNAT

Miten varoitus vaikutti ajamisen ohessa tekemiisi toimintoihin?

- ☐ ei mitenkään
- ☐ radion käyttöön, miten? _____
- ☐ matkapuhelimen käyttöön, miten? _____
- ☐ muiden ajoneuvossa olevien laitteiden käyttöön, miten? _____
- ☐ keskusteluun kanssamatkustajien kanssa, miten? _____
- ☐ vasta porojen näkeminen vaikutti oheistoimintoihin
- ☐ muuten, miten? _____
- ☐ en osaa sanoa

VAROITUKSESTA KESKUSTELU

Jos mukanasi oli matkustaja, keskustelitteko varoituksesta sen saatuanne?

- ☐ Kyllä, keskustelimme varoituksen tarkoituksesta.
- ☐ Kyllä, mietimme, mitä pitäisi tehdä.
- ☐ Keskustelimme varoituksesta vasta, kun näimme poron.
- ☐ Ei keskusteltu.
- ☐ Ei, ajoin yksin.
- ☐ Muuta, mitä? _____

TARKKAAVAISUUDEN SUUNTAAMINEN

Miten varoitus vaikutti tarkkaavaisuutesi suuntaamiseen (mitä tietoa haet liikenneympäristöstä)?

- ☐ ei mitenkään
- ☐ seurasin enemmän tienpientareita mahdollisten porojen ja muiden eläinten takia
- ☐ keskityin enemmän omaan ajamiseen
- ☐ seurasin enemmän henkilö- ja pakettiautojen käyttäytymistä
- ☐ seurasin enemmän toisten kuorma-, linja- ja rekka-autojen käyttäytymistä
- ☐ seurasin enemmän takana tulevaa liikennettä
- ☐ seurasin enemmän edellä ajavaa ajoneuvoa
- ☐ seurasin enemmän vastaantulevaa liikennettä
- ☐ seurasin enemmän jalankulkijoiden ja polkupyöräilijöiden käyttäytymistä
- ☐ kiinnitin huomiota ajokeliin
- ☐ tarkkaavaisuuteni lisääntyi vasta, kun näin poron
- ☐ muuten, miten? _____
- ☐ en osaa sanoa

MUU VAIKUTTAMINEN

- ◯ kyllä, miten? _____
- ◯ ei vaikuttanut
- ◯ en osaa sanoa

Osa 3 – Porokelloon liittyvät yleiset kysymykset

Kuinka tyytyväinen olet Porokellon toimintaan? Osoita mielipiteesi mitta-asteikolla, valitse yksi vastaus riviä kohti.

	Erittäin tyytyväinen	Melko tyytyväinen	En tyytyväinen enkä tyytymätön	Melko tyytymätön	Erittäin tyytymätön
Varoituksen ymmärrettävyys	◯	◯	◯	◯	◯
Varoituksen luotettavuus	◯	◯	◯	◯	◯
Varoituksen ajoitus	◯	◯	◯	◯	◯
Varoituksen hyödyllisyys	◯	◯	◯	◯	◯
Saapuvan varoituksen huomaaminen	◯	◯	◯	◯	◯

Kuinka kuvaisit Porokelloa kokemuksiesi perusteella? Osoita mielipiteesi mitta-asteikolla, valitse yksi vastaus riviä kohti.

	1	2	3	4	5	
Hyödyllinen	◯	◯	◯	◯	◯	Hyödytön
Miellyttävä	◯	◯	◯	◯	◯	Epämiellyttävä
Huono	◯	◯	◯	◯	◯	Hyvä
Tarpeet tyydyttävä	◯	◯	◯	◯	◯	Pettymys
Tehokas	◯	◯	◯	◯	◯	Tehoton
Ärsyttävä	◯	◯	◯	◯	◯	Miellyttävä
Avustava	◯	◯	◯	◯	◯	Häiritsevä
Epämieluisa	◯	◯	◯	◯	◯	Mieluisa
Vireyttä lisäävä	◯	◯	◯	◯	◯	Unettava

Kyselyn yhtenä tarkoituksena on hakea tietoa siitä, puuttuuko varoittajia joiltakin alueilta. Onko joitakin tiettyjä tieosuuksia, joissa olet usein havainnut poroja, mutta et ole saanut varoitusta?

- ◯ kyllä, missä? _____
- ◯ ei

Porokellon varoitus on nykyään voimassa puoli tuntia sen antohetkestä. Kesäkuun 2018 loppuun asti varoitus oli päällä tunnin. Kuinka pitkäkestoisia varoitusten pitäisi sinun mielestäsi olla?

- ◯ tunti
- ◯ puoli tuntia
- ◯ muu, mikä? _____
- ◯ en osaa sanoa

Keiden tulisi mielestäsi voida toimia Porokello-varoittajana

- ◯ kaikki autoilijat
- ◯ kaikki autoilijat, mutta erikseen rekisteröityneenä
- ◯ vain ammattiautoilijat
- ◯ en osaa sanoa

Mitkä ovat mielestäsi Porokellon hyvät puolet?

Mitkä ovat mielestäsi Porokellon huonot puolet?

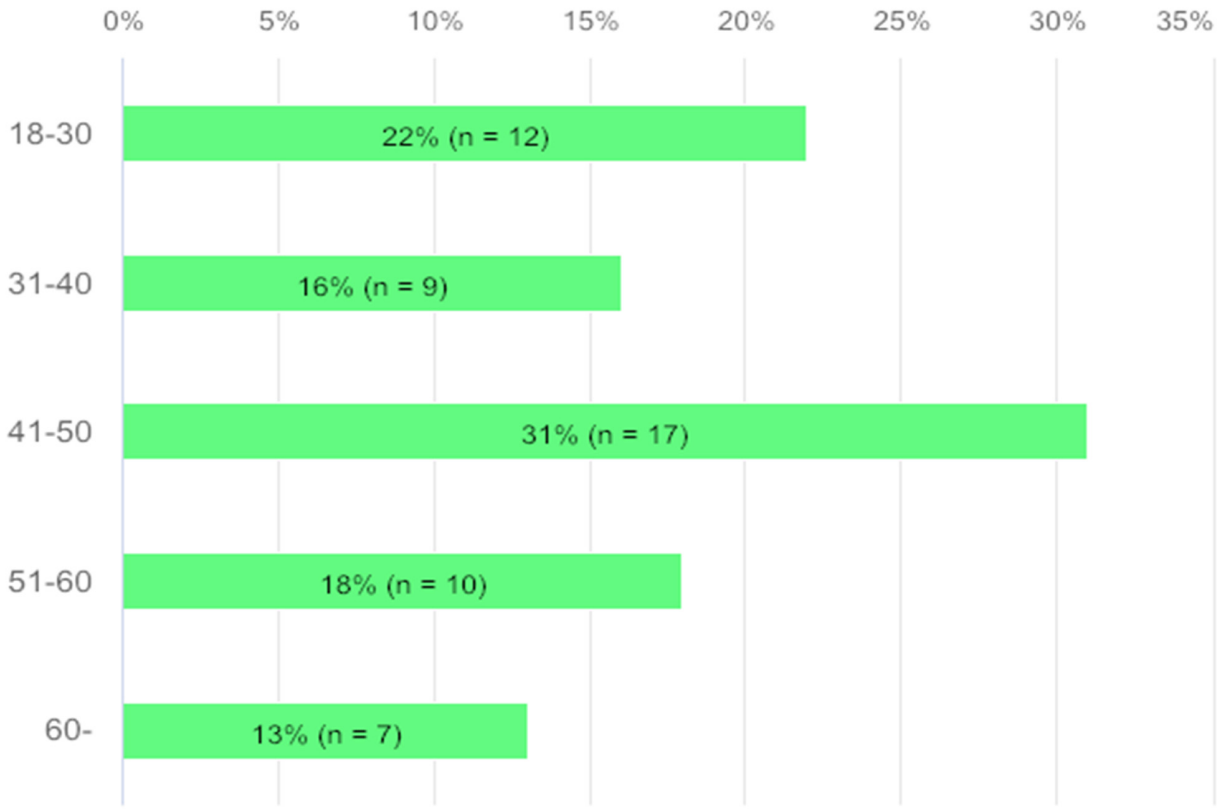
Mitä Porokellon ominaisuuksia pitäisi mielestäsi kehittää ja miten?

Jos olet saanut varoituksia, mutta et ole nähnyt poroja varoitusalueella, millaisia vaikutuksia näillä tapauksilla mielestäsi on ollut? (luotettavuus, miellyttävyys, kyllästyminen...)

Miltä ajaminen Porokellon kanssa tuntuu? Jos haluat vielä kommentoida Porokelloa tai kyselyä, sana on vapaa!

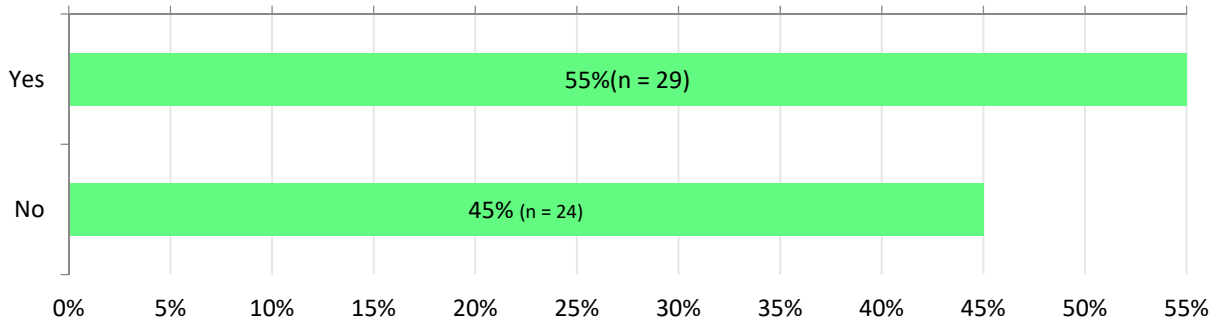
Name of report: Questionnaire PERSONS GIVING WARNINGS
Headline of report: Impact evaluation of the Porokello alert service
Total number of respondents: 55

1. Your age?
Number of respondents: 55

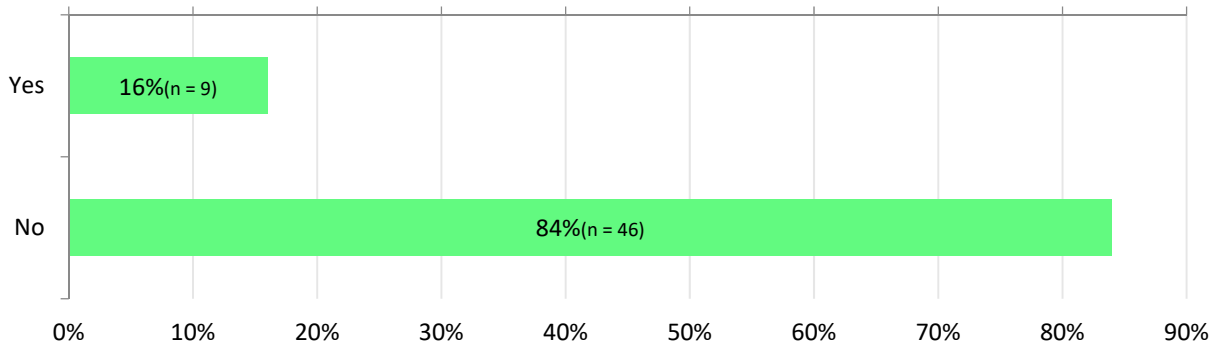


	n	Per cent
18-30	12	21,82%
31-40	9	16,36%
41-50	17	30,91%
51-60	10	18,18%
60-	7	12,73%

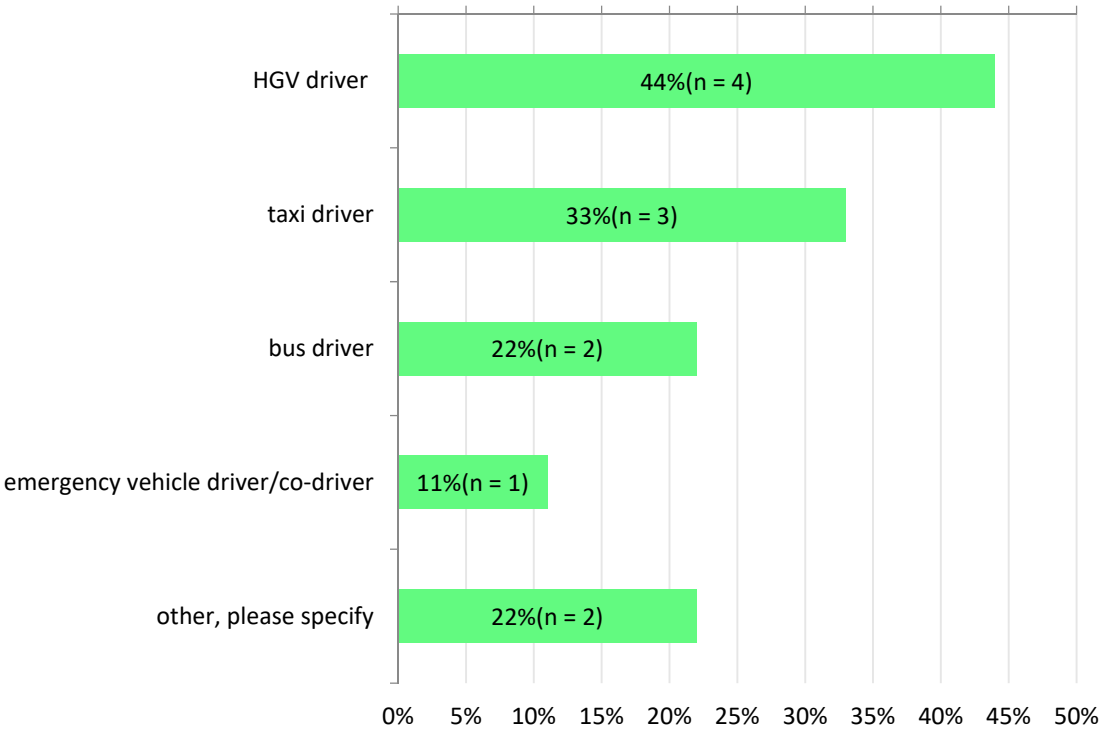
2. Do you or your family members own reindeer?
Number of respondents: 53



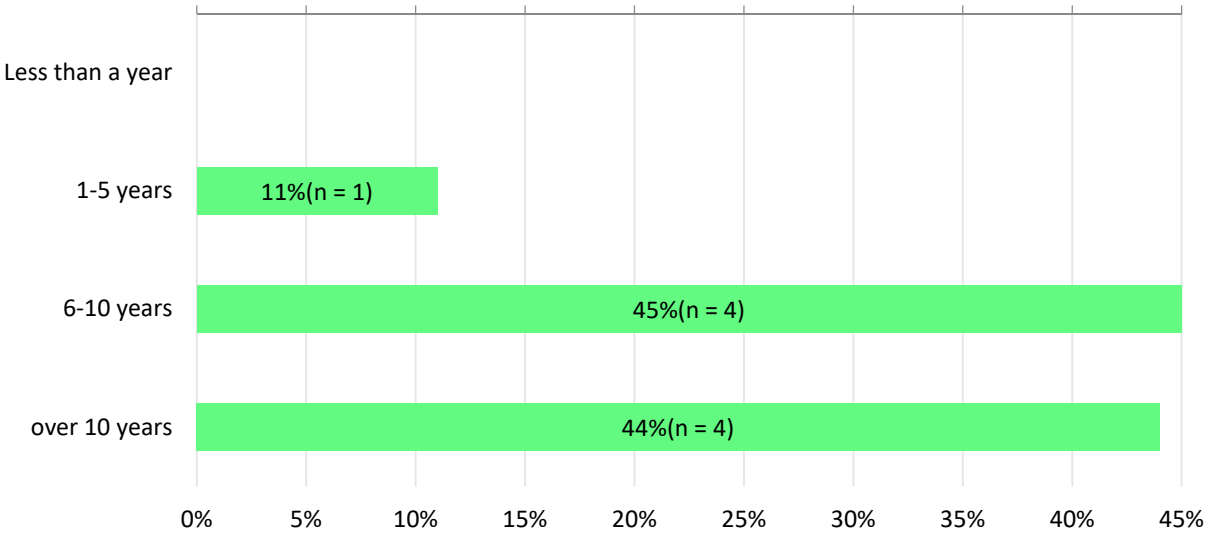
3. Are you a professional driver? (heavy vehicle, taxi, bus, emergency vehicle)
Number of respondents: 55



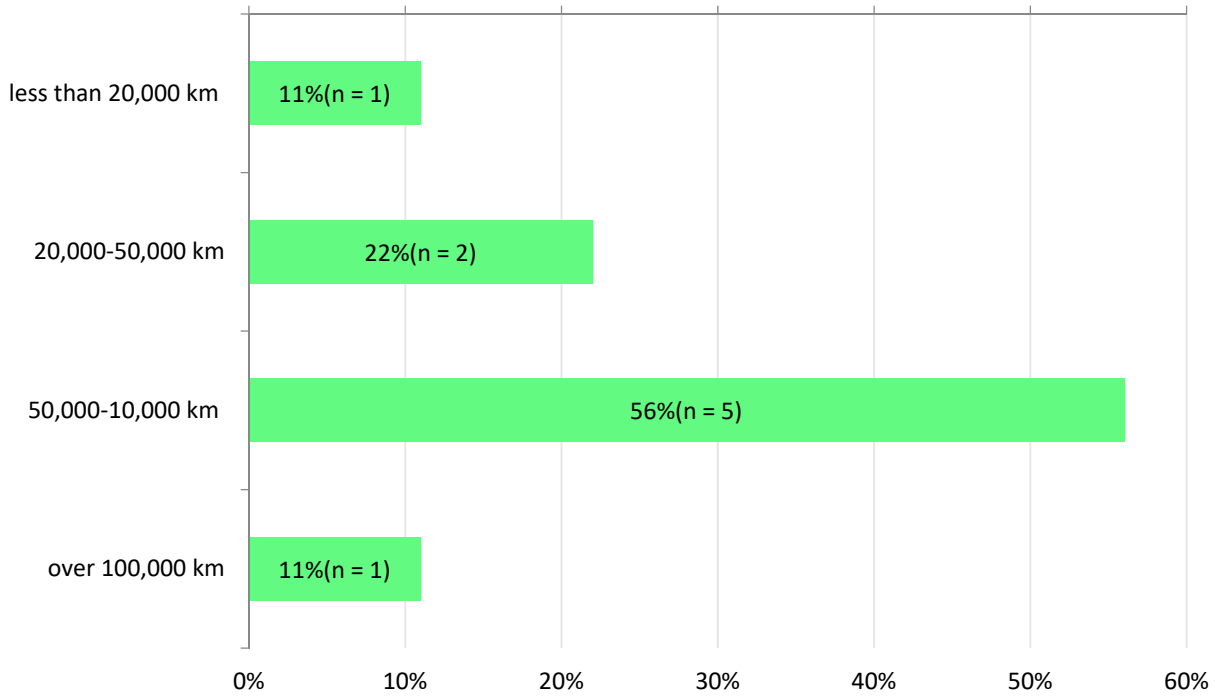
4. What is your profession??
Number of respondents: 9, Number of chosen answers: 12



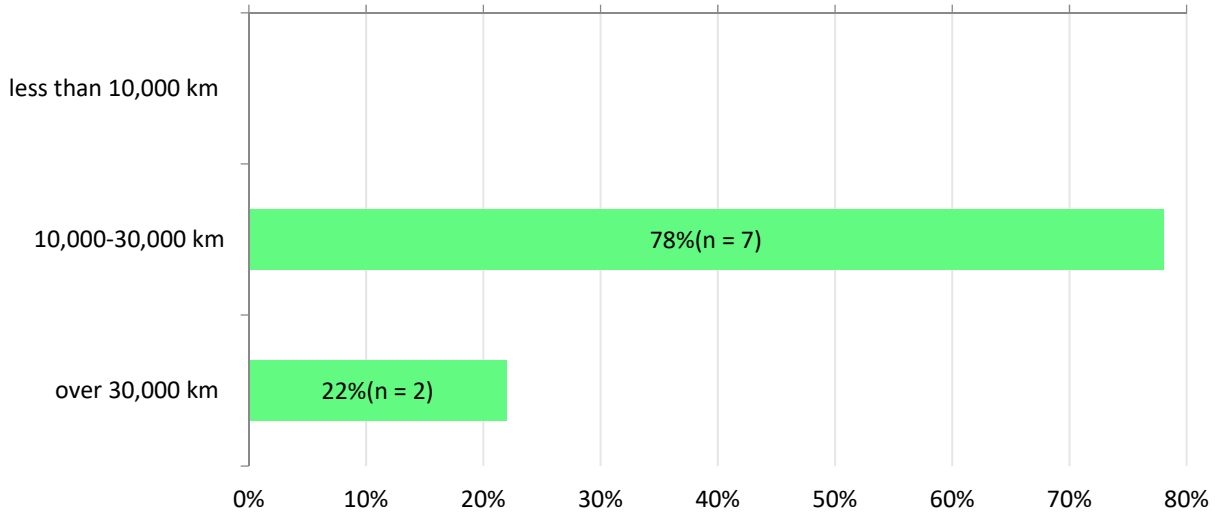
5. How long have you been a professional driver?
Number of respondents: 9



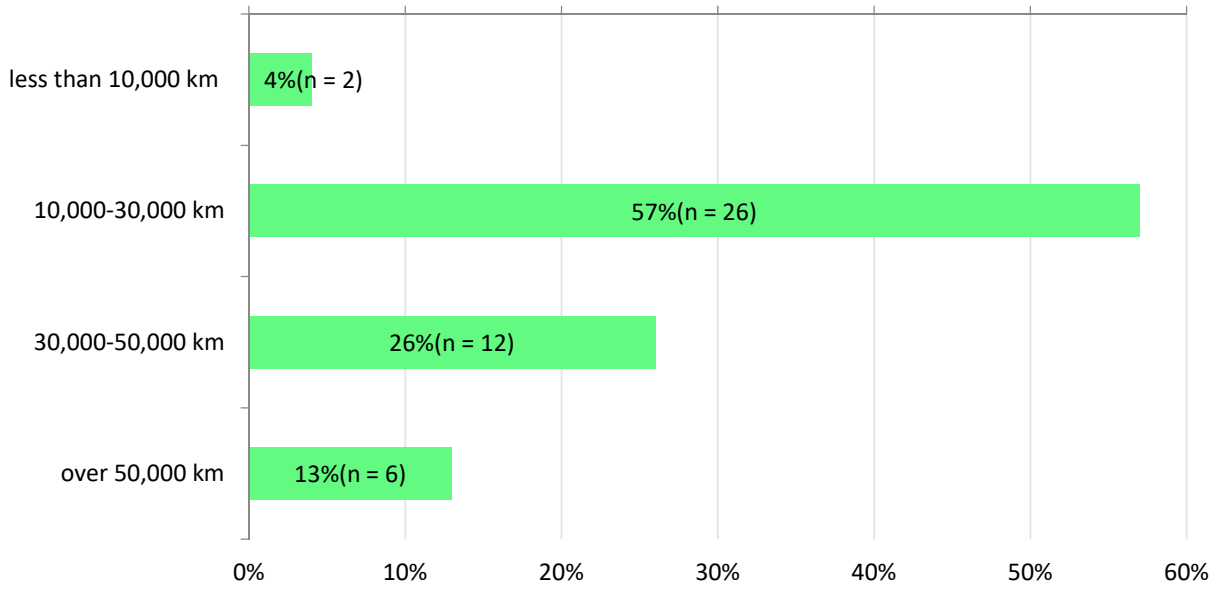
6. How many kilometres do you drive for work per year?
Number of respondents: 9



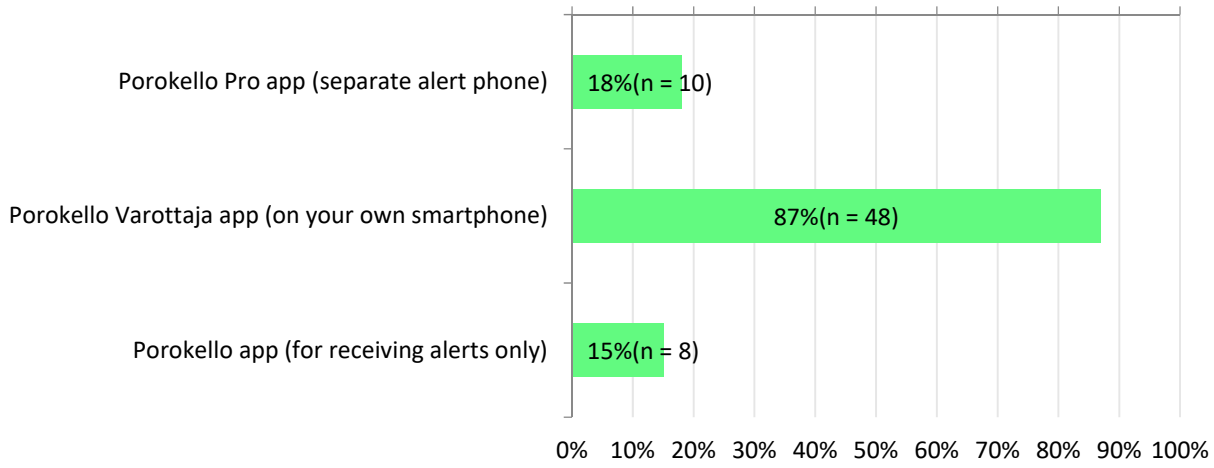
7. How many kilometres do you drive in your free time per year?
Number of respondents: 9



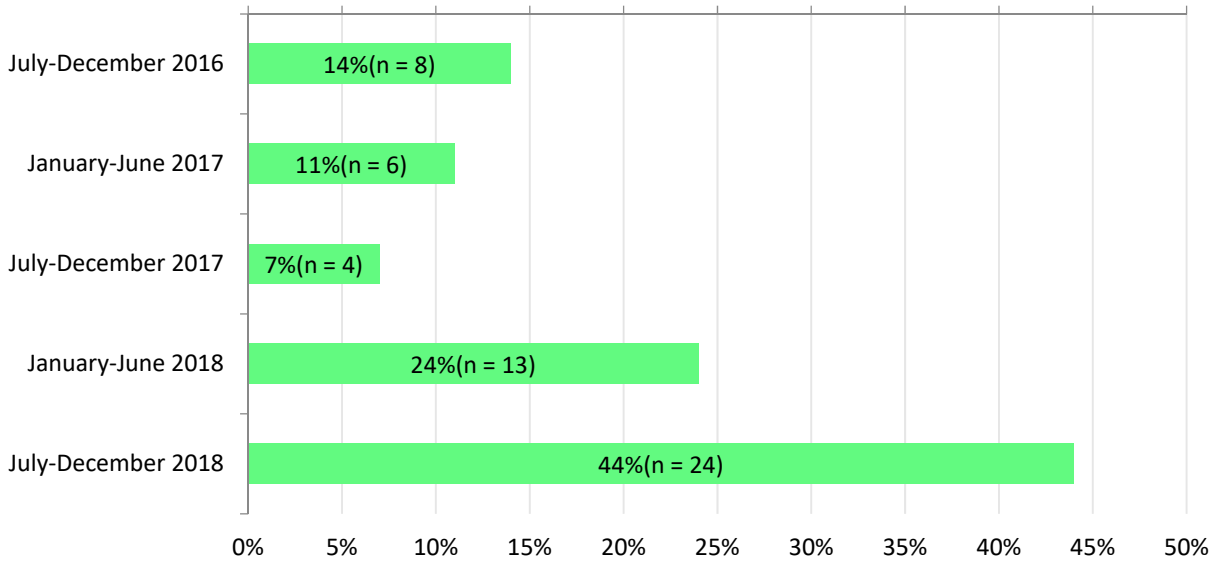
8. On average, how many kilometres do you drive per year?
Number of respondents: 46



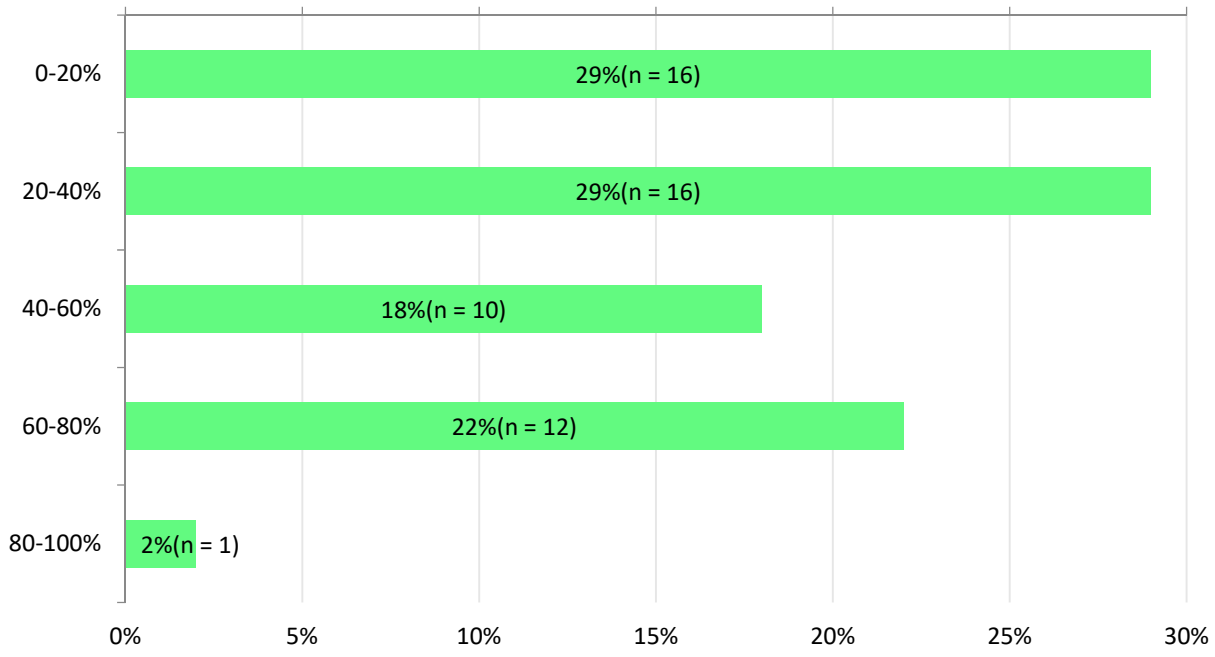
9. Do you use: (you can select multiple answers)
Number of respondents: 55, Number of chosen answers: 66



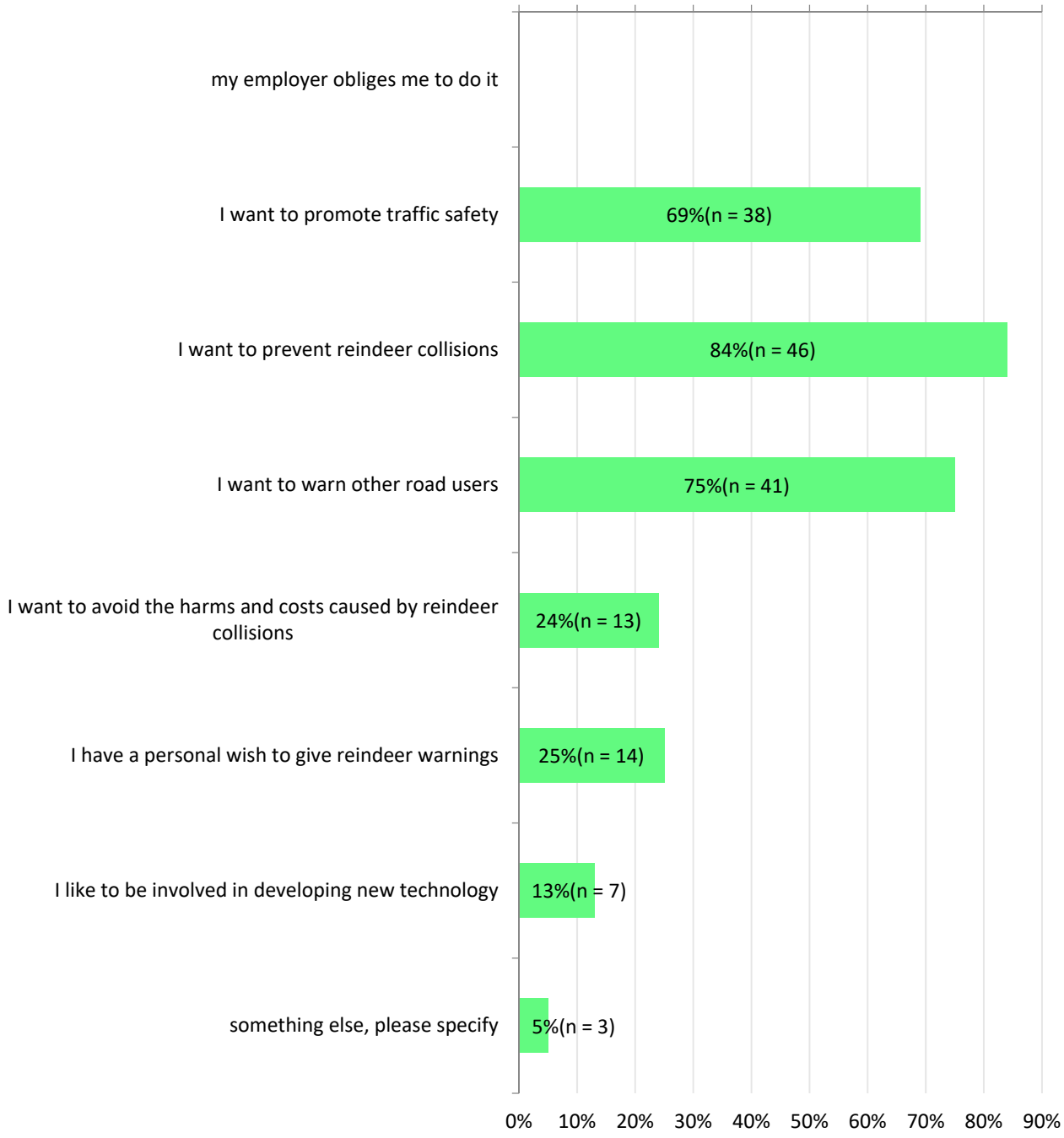
10. When did you begin to give warnings as a user of Porokello?
Number of respondents: 55



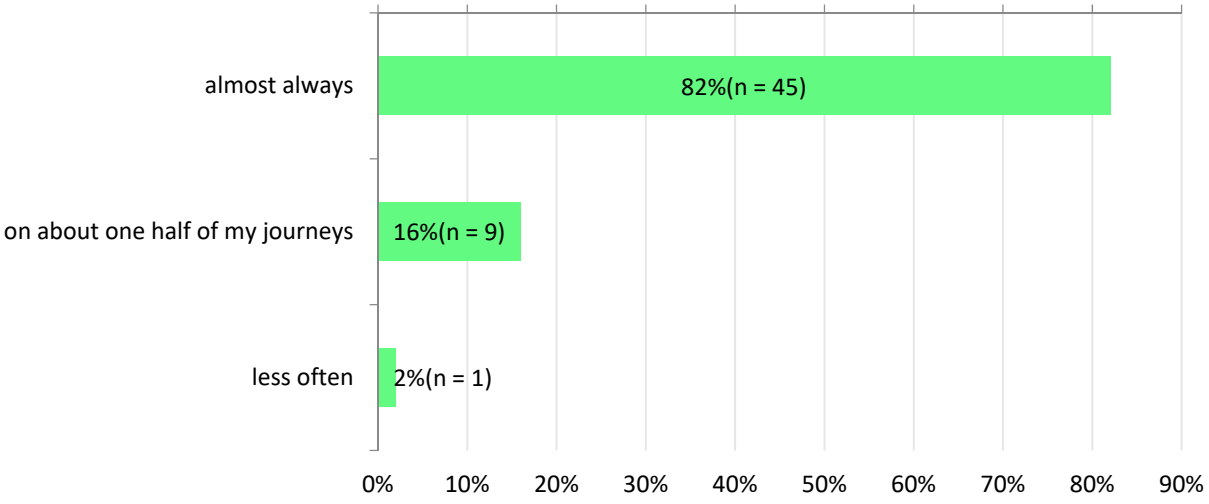
11. How large a portion of your encounters with reindeer have been preceded by an alert? Think about the year 2018.
Number of respondents: 55



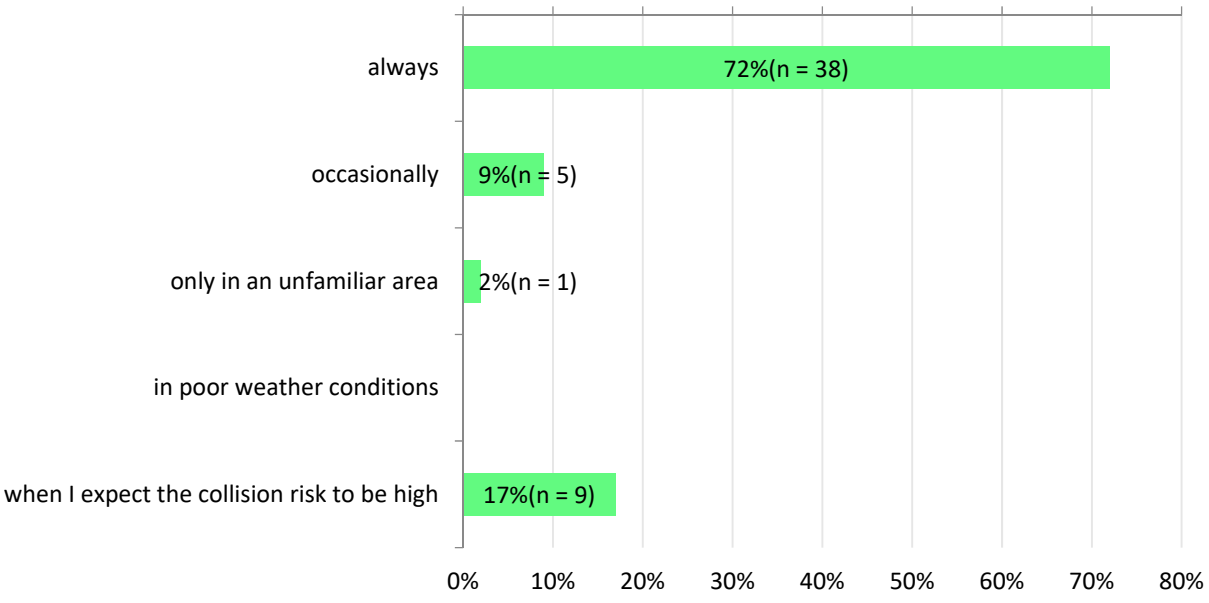
12. What are your main motives for giving warnings through Porokello? Choose three most important motives.
Number of respondents: 55, Number of chosen answers: 162



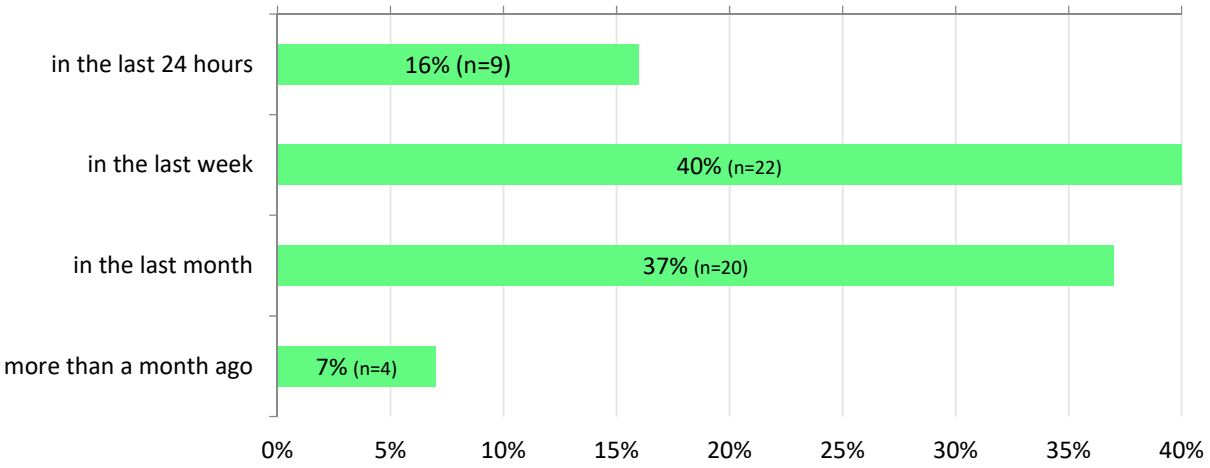
13. How often do you have the Porokello service on while driving?
Number of respondents: 55



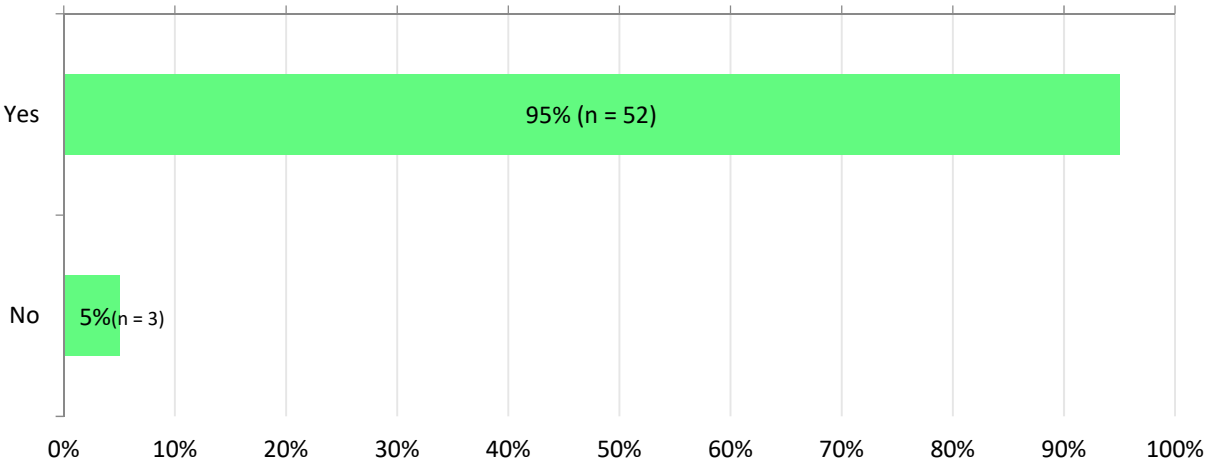
14. How often do you have the Porokello service on while driving in the reindeer husbandry area?
Number of respondents: 53



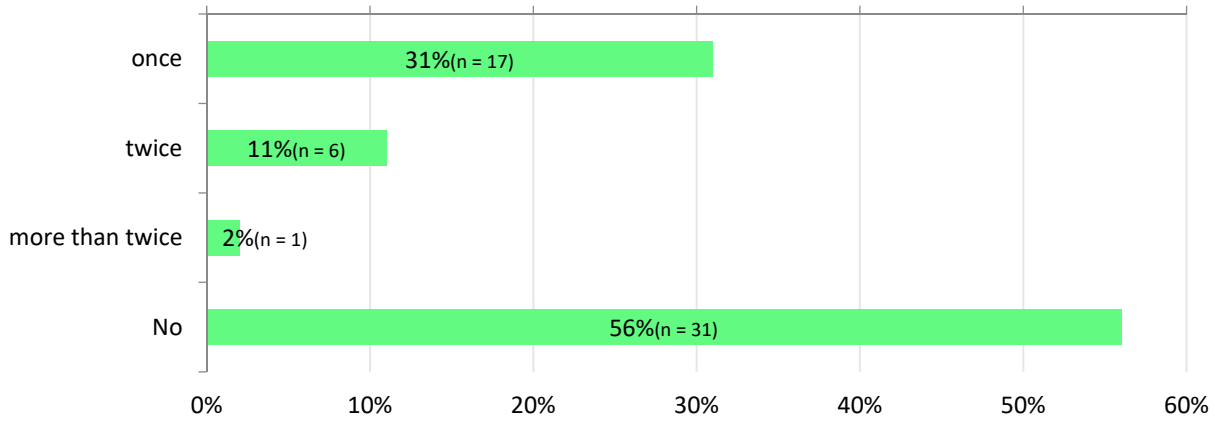
15. When was the last time you gave a warning?
Number of respondents: 55



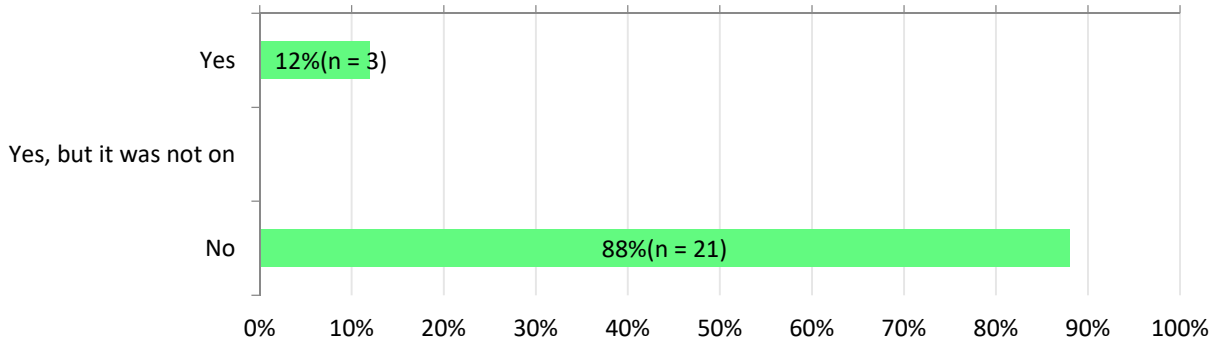
16. Do you give a new warning if you see a reindeer in the area where a warning is still valid?
Number of respondents: 55



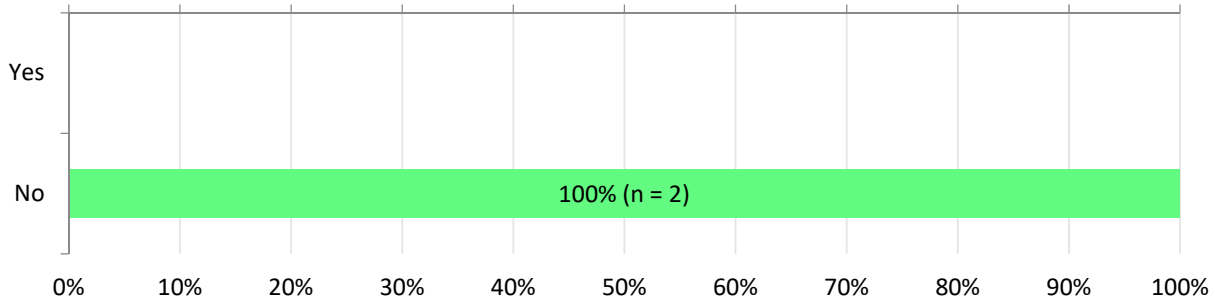
17. Have you been involved in a reindeer collision?
Number of respondents: 55



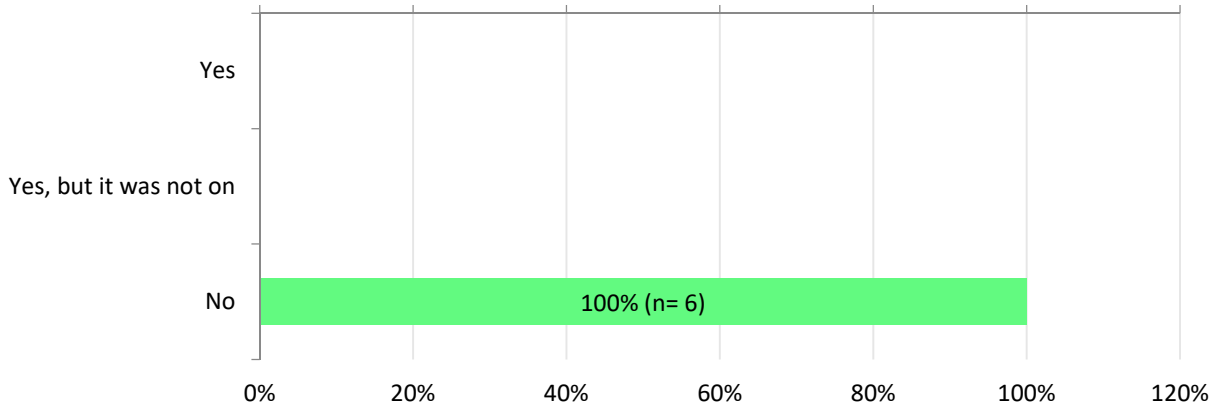
18. Did you use the Porokello service at the time? (collision 1)
Number of respondents: 24



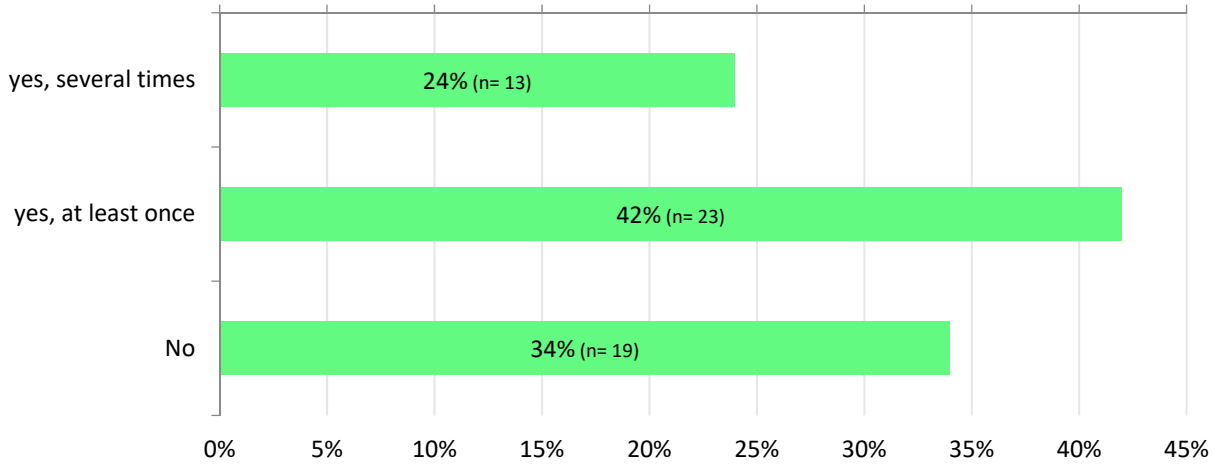
19. Did you receive an alert?
Number of respondents: 2



20. Did you use the Porokello service at the time? (collision 2)
Number of respondents: 6

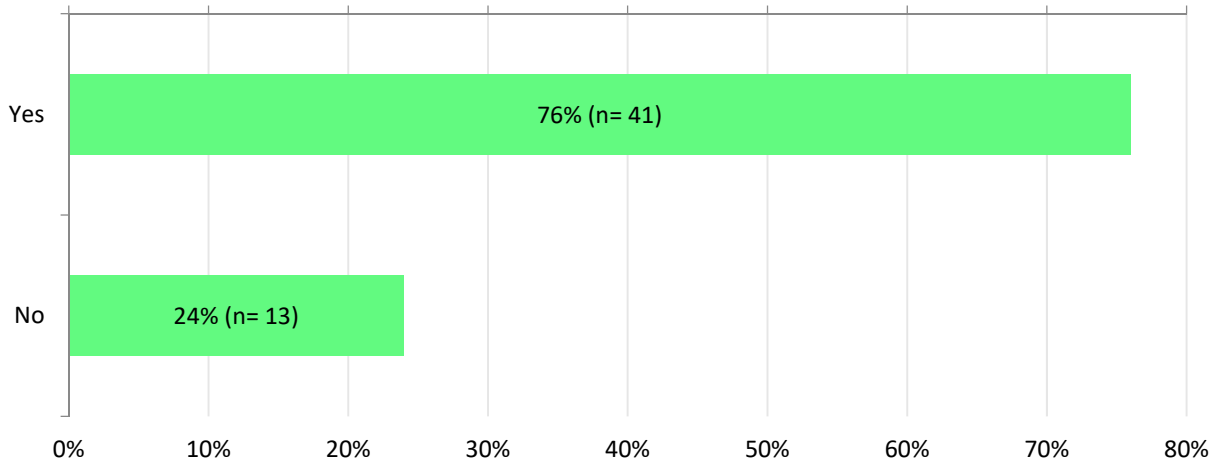


22. Have you possibly avoided a collision with the help of Porokello?
Number of respondents: 55

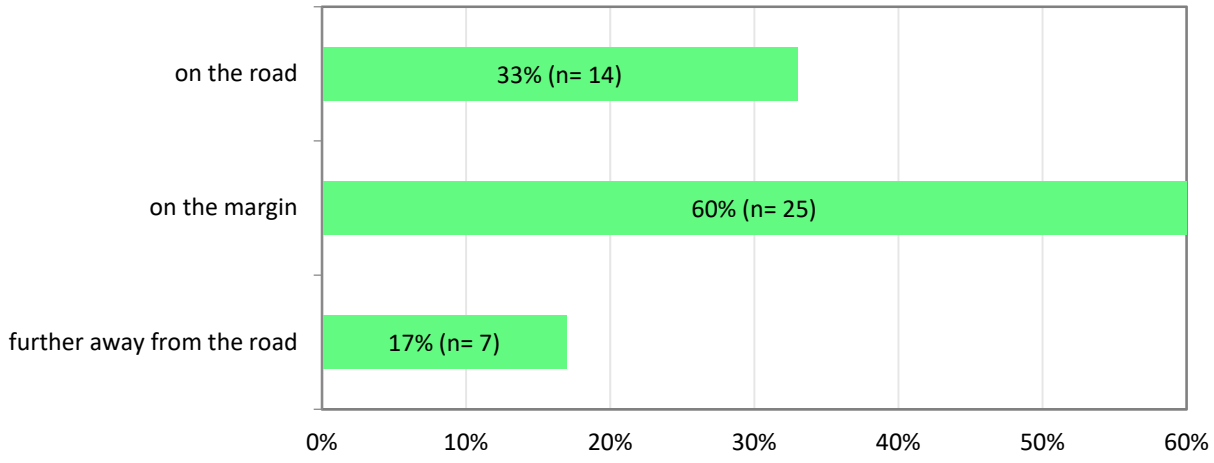


Think about the last time you received a Porokello alert. When did this occur? Did you see reindeer? Answer the following questions based on this incident.

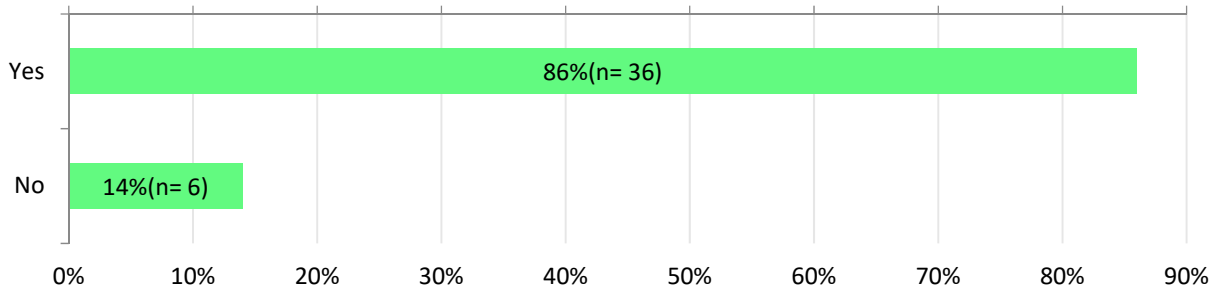
23. I noticed reindeer in the alert area
Number of respondents: 54



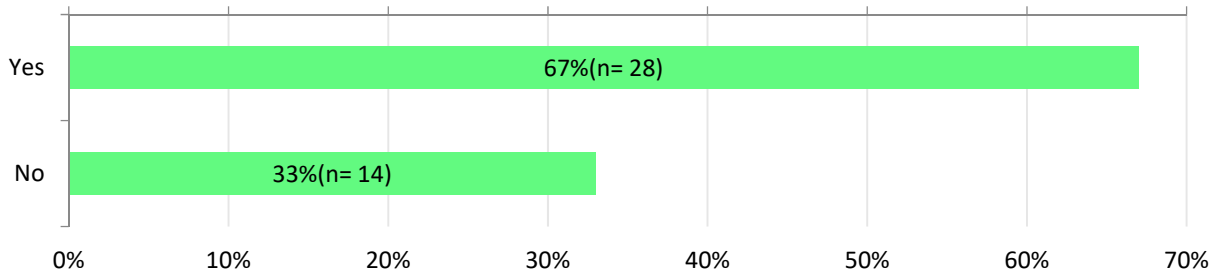
24. The reindeer in the alert area were:
Number of respondents: 42, Number of chosen answers: 46



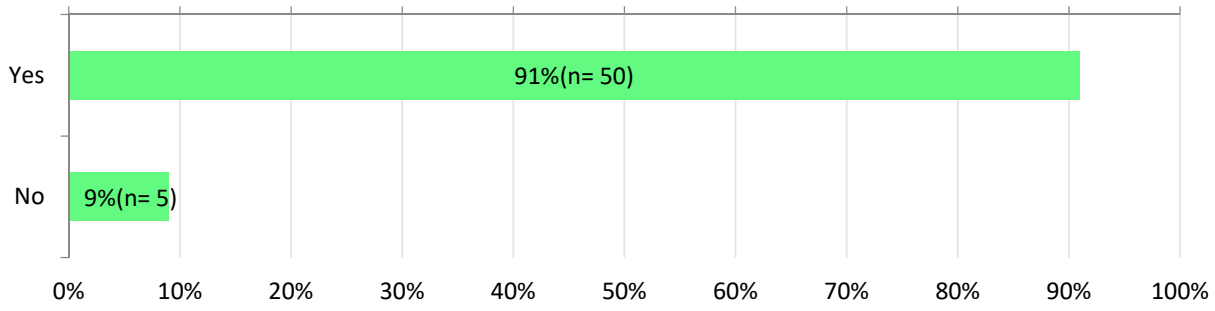
25. I would have noticed the reindeer also without the alert
Number of respondents: 42



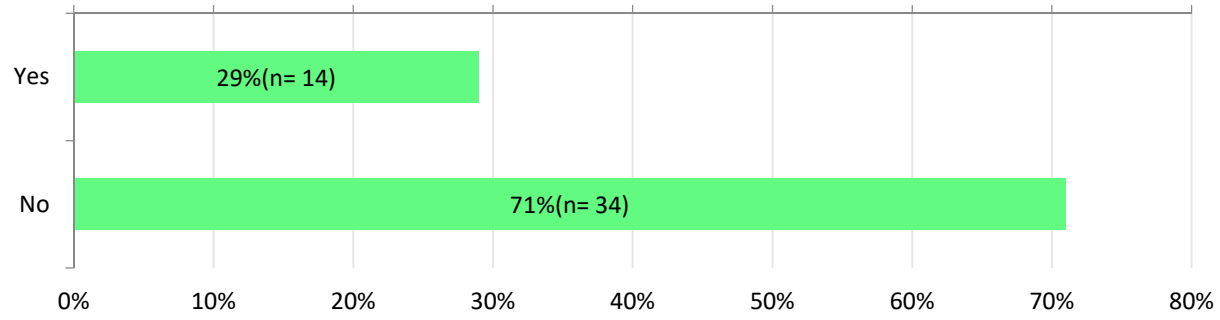
26. Because of the alert, I noticed the reindeer earlier than I would have done without the alert
Number of respondents: 42



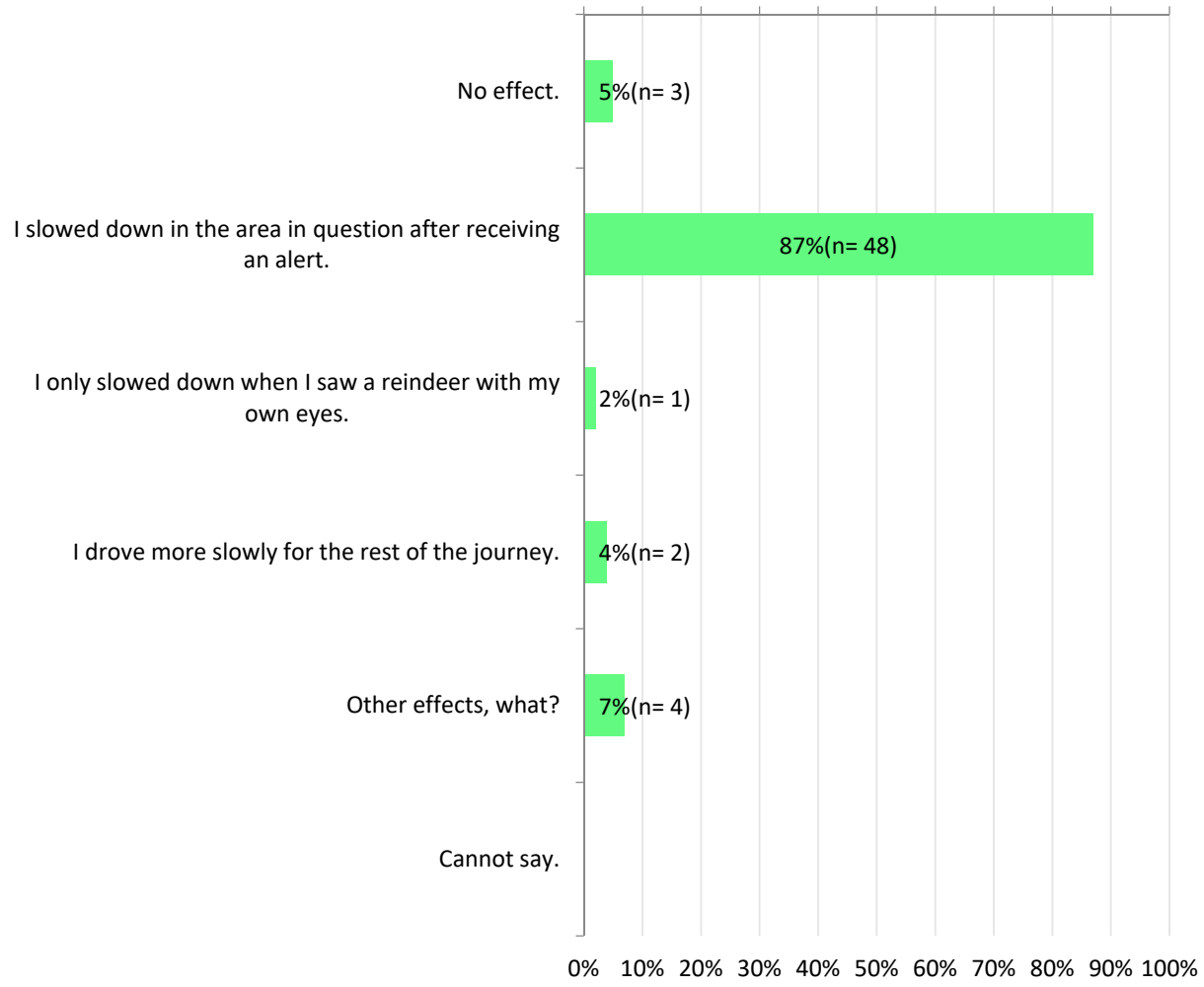
27. I got prepared or changed my driving behaviour after receiving the reindeer alert
Number of respondents: 55



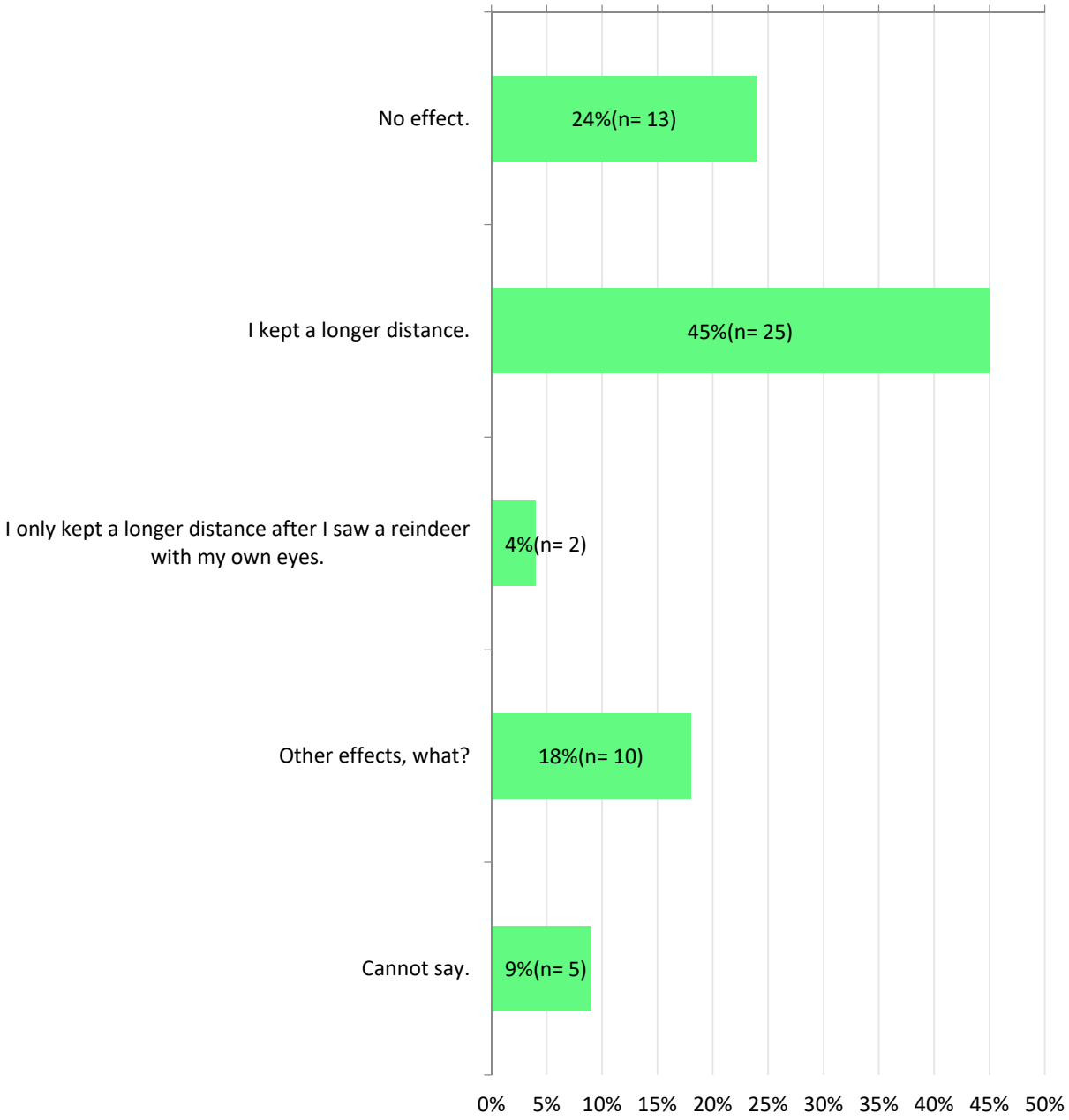
28. I avoided a collision because of the alert
Number of respondents: 48



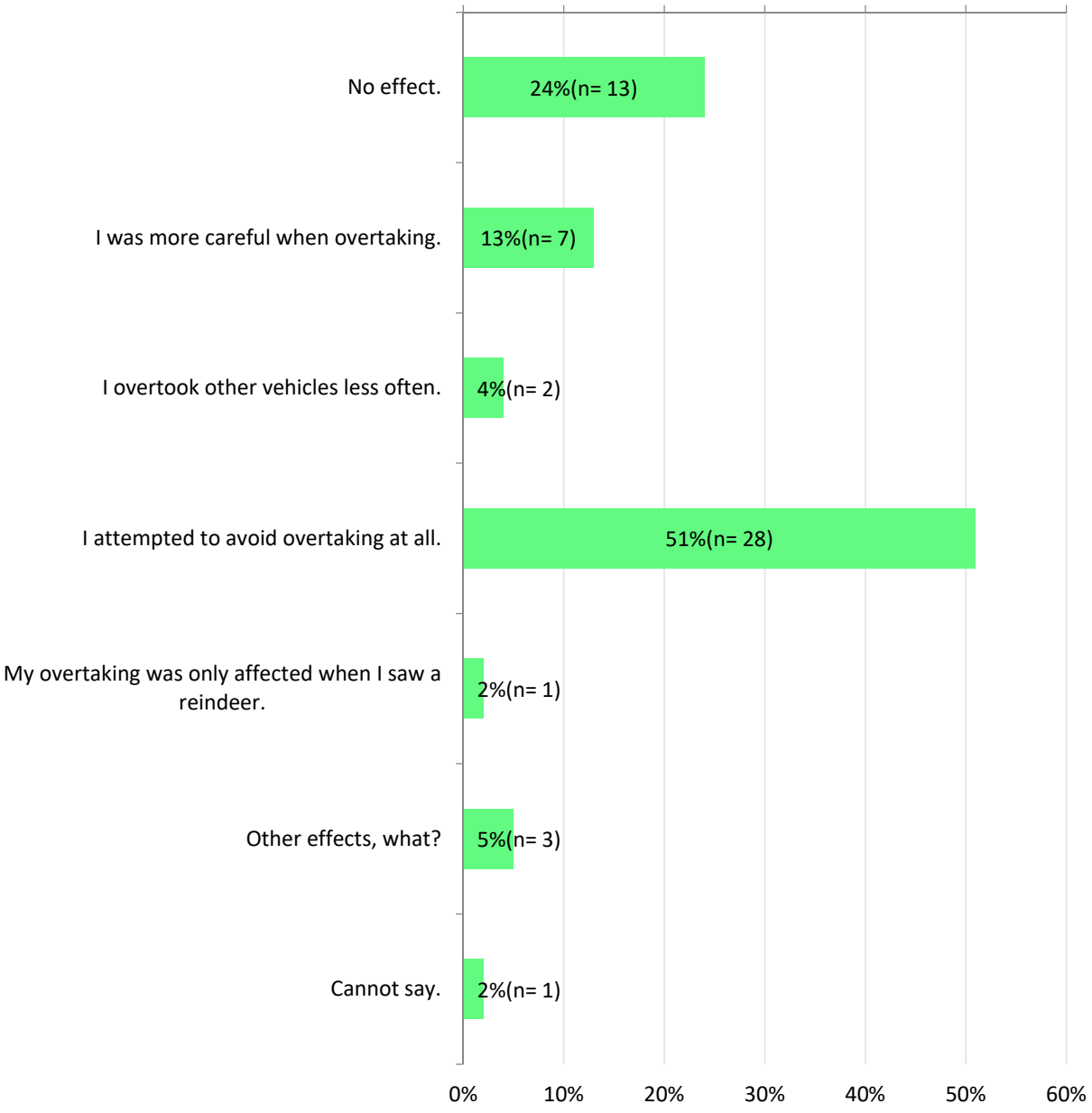
29. DRIVING SPEED How did the alert affect your driving speed?
Number of respondents: 55, Number of chosen answers: 58



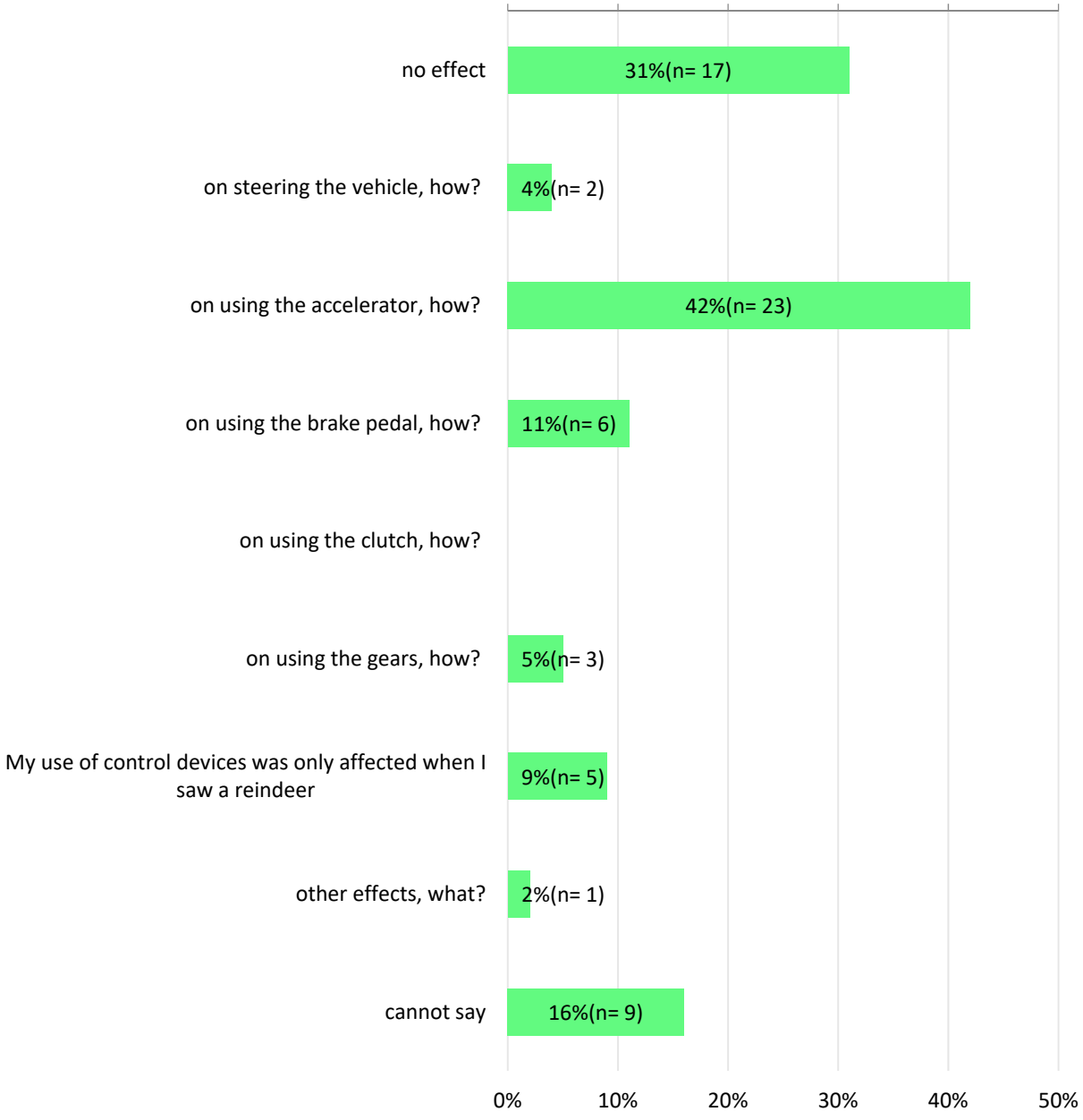
30. DISTANCE TO THE VEHICLE AHEAD How did the alert affect your distance to the vehicle ahead?
Number of respondents: 55



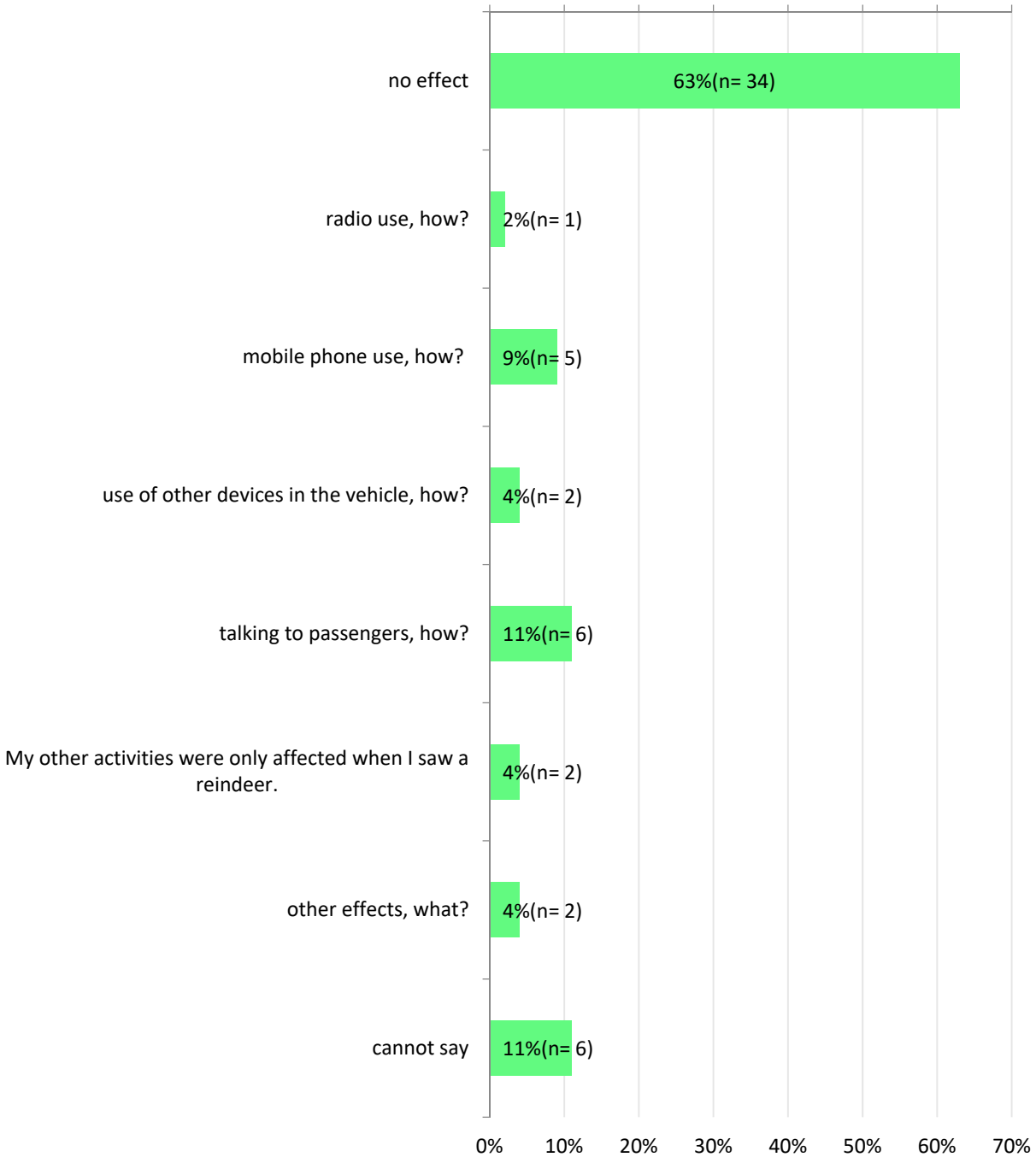
31. OVERTAKING: How did the alert affect your overtaking behaviour?
Number of respondents: 55, Number of chosen answers: 55



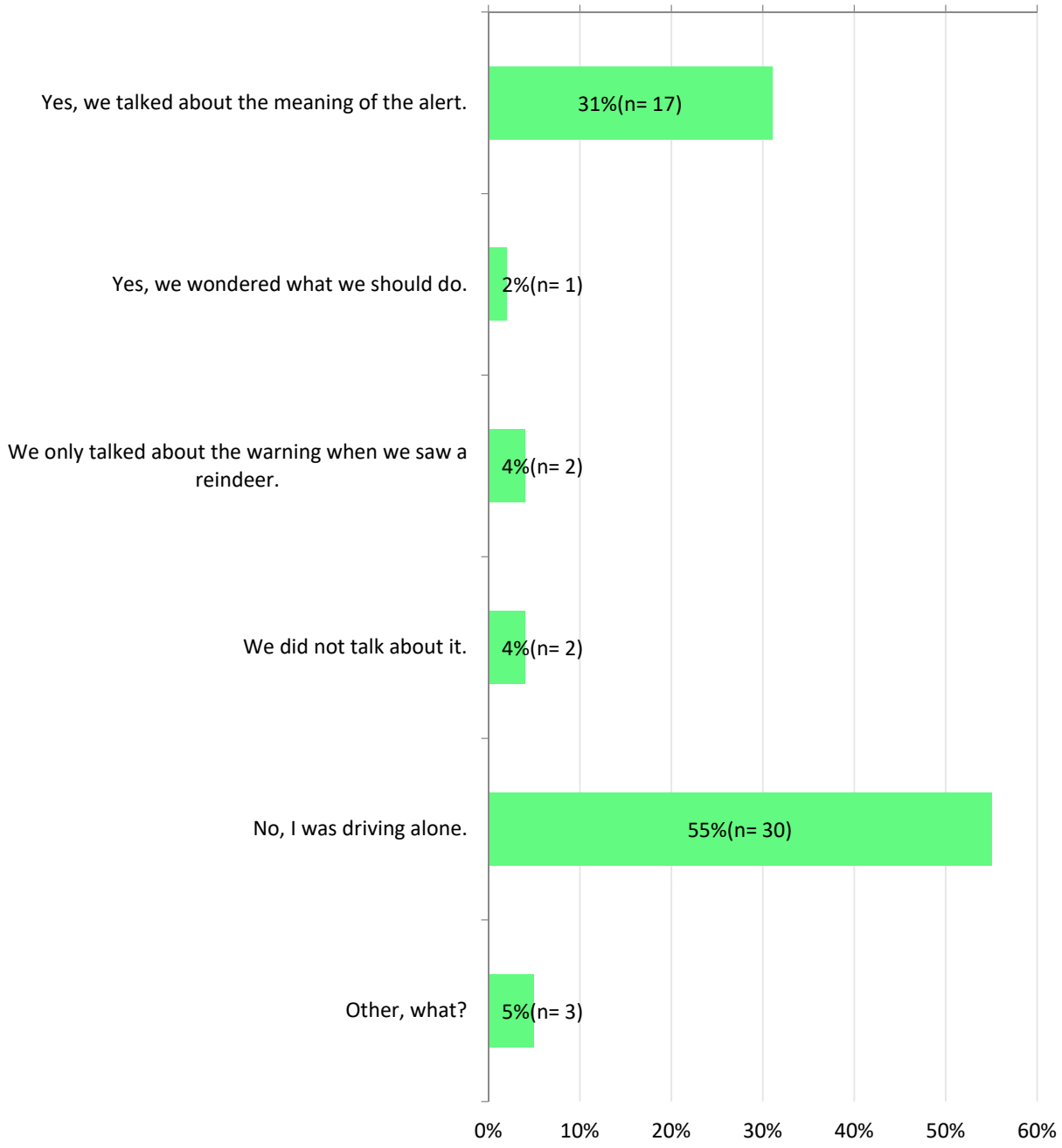
32. USE OF CONTROL DEVICES: How did the alert affect your use of control devices (steering wheel, pedals, gears, other control devices)?
Number of respondents: 55, Number of chosen answers: 66



33. ACTIVITIES PERFORMED WHILE DRIVING How did the alert affect on the activities performed while driving?
Number of respondents: 54, Number of chosen answers: 58

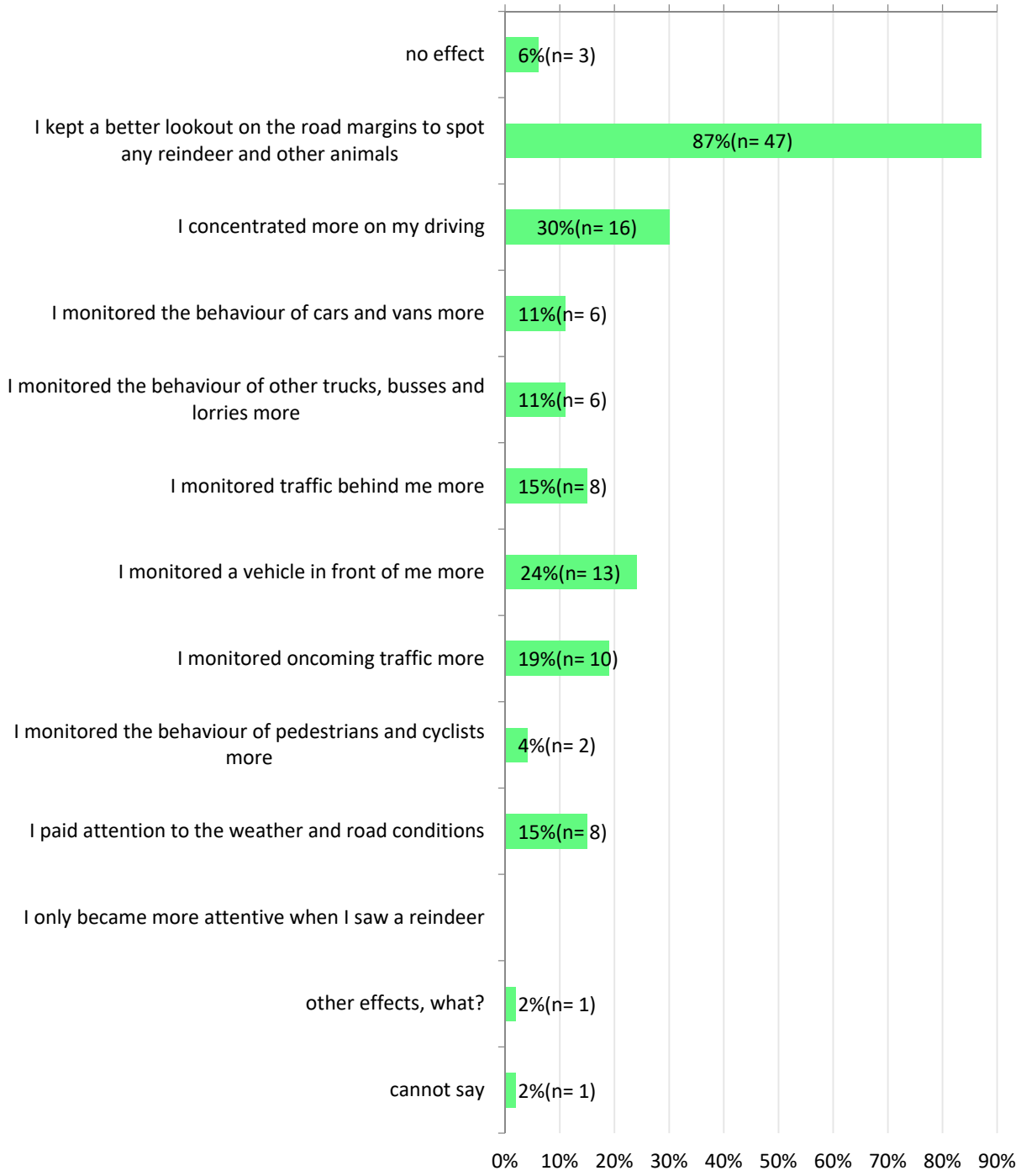


34. DISCUSSING THE ALERT If you had a passenger, did you discuss the alert after receiving it??
Number of respondents: 55, Number of chosen answers: 55

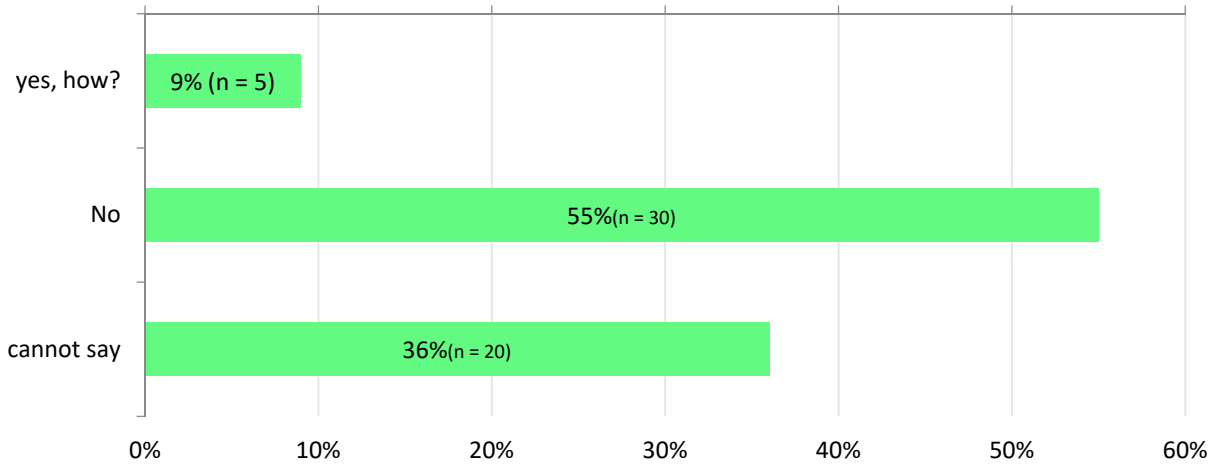


35. FOCUSING ATTENTION

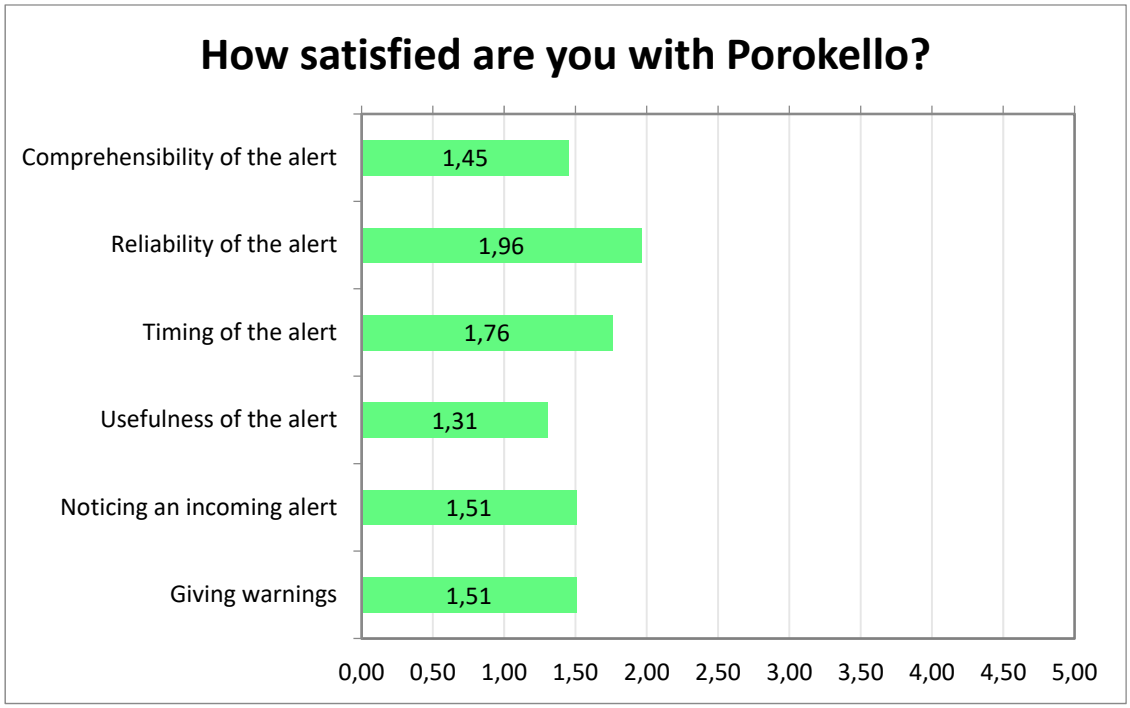
How did the alert affect the way you focused your attention (what kind of information did you seek for in the traffic environment)?
Number of respondents: 54, Number of chosen answers: 121



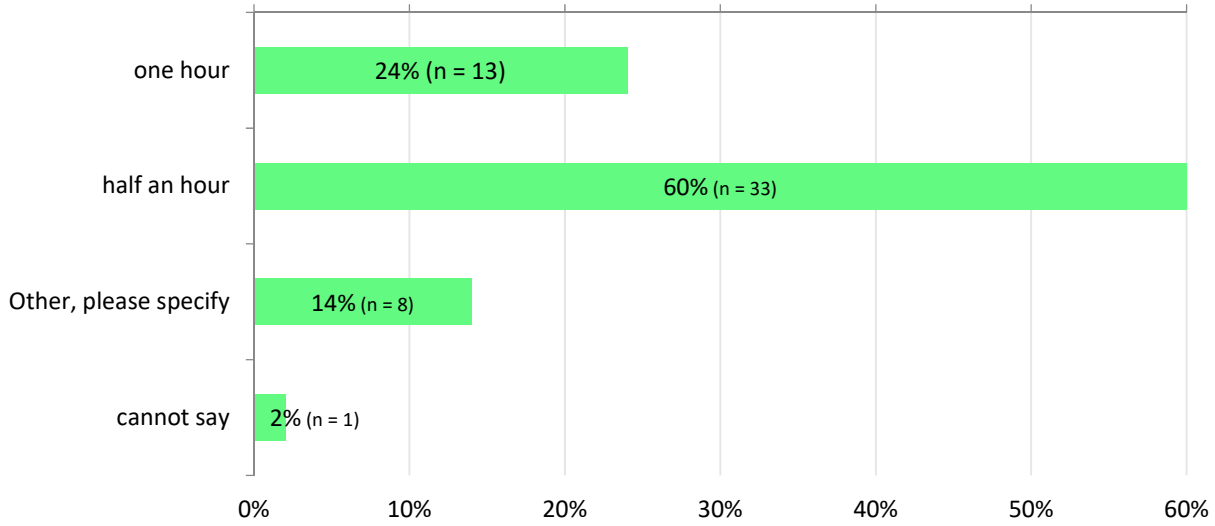
36. OTHER IMPACTS: Did receiving the alert have any other impacts?
Number of respondents: 55



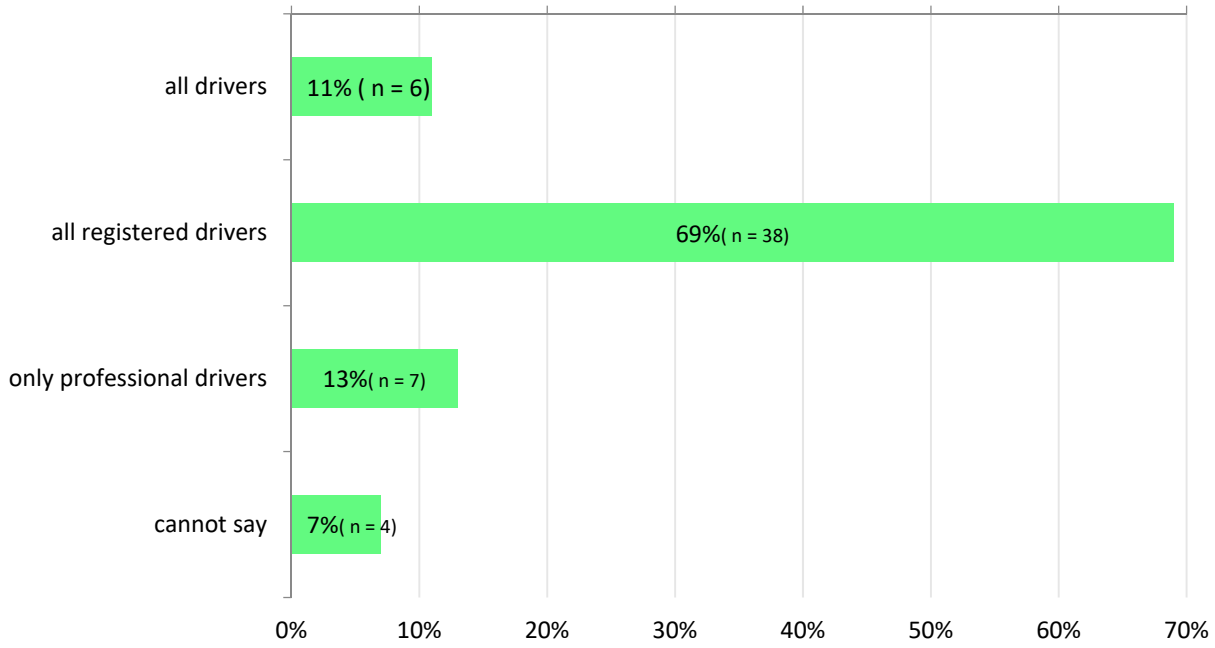
37. How satisfied are you with Porokello?? Give your opinion on a numeric scale by choosing one answer per row.
Number of respondents: 55



40. A Porokello alert is currently valid for half an hour. Until June 2018, the validity period was one hour. How long should a Porokello alert be valid?
Number of respondents: 55



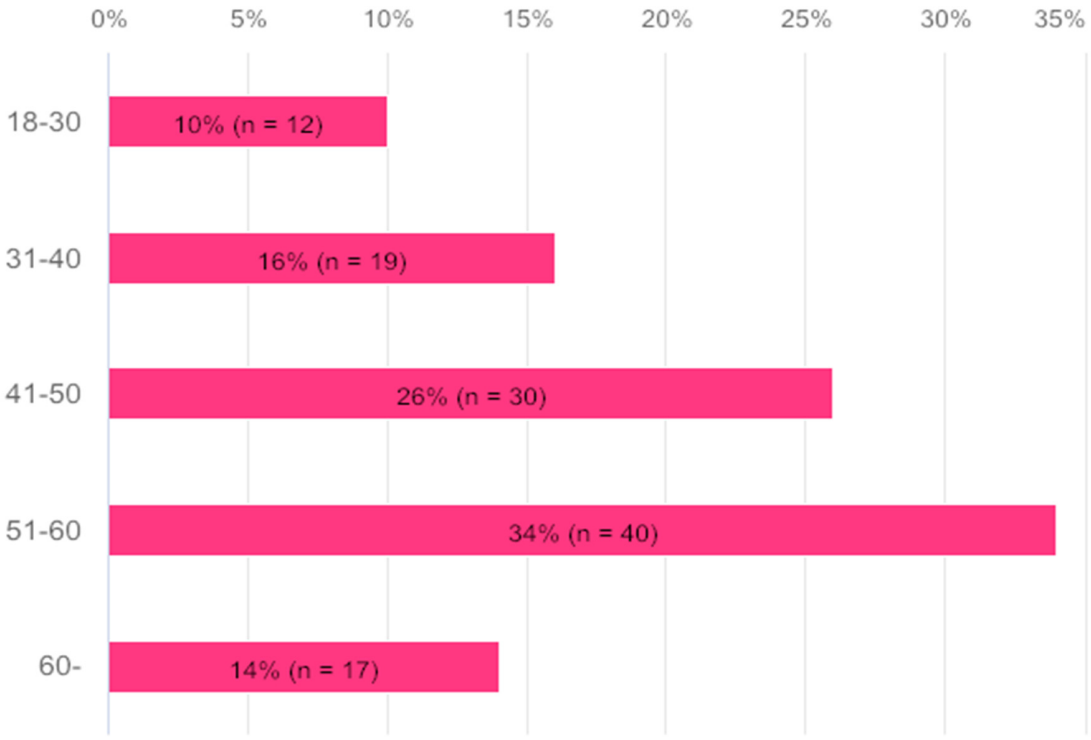
41. Who should be able to give Porokello warnings?
Number of respondents: 55



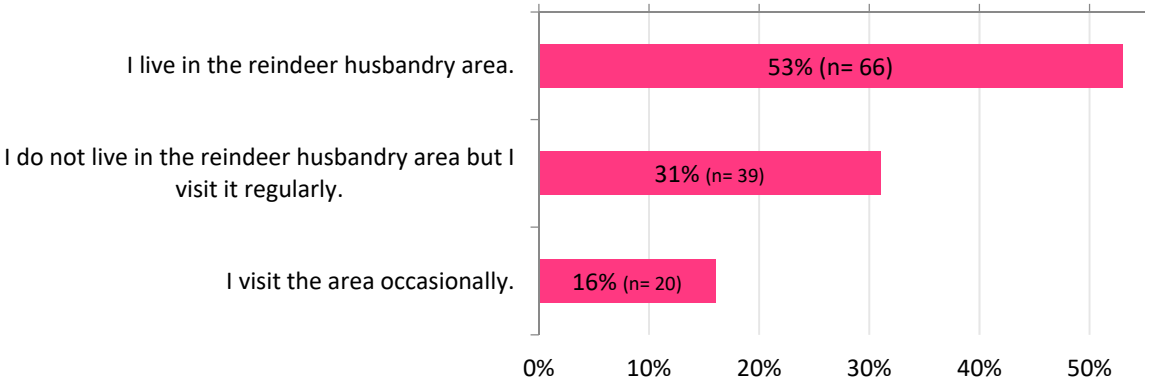
Name of report: Questionnaire USERS
Headline of report: Impact evaluation of the Porokello alert service

Total number of respondents: 125

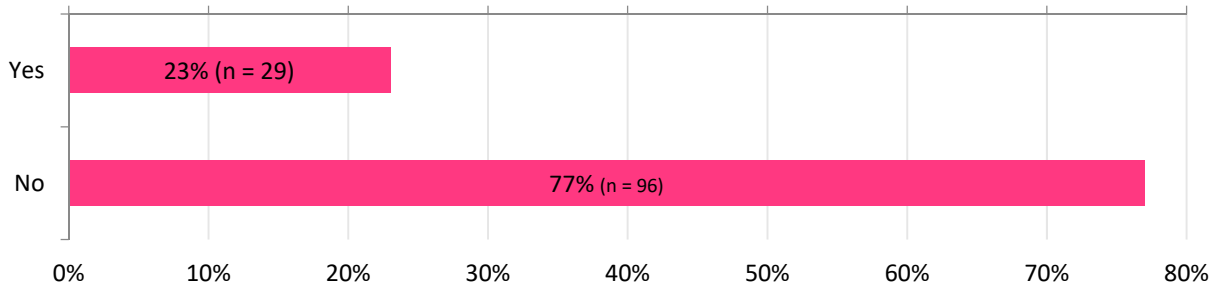
1. Your age?
Number of respondents: 118



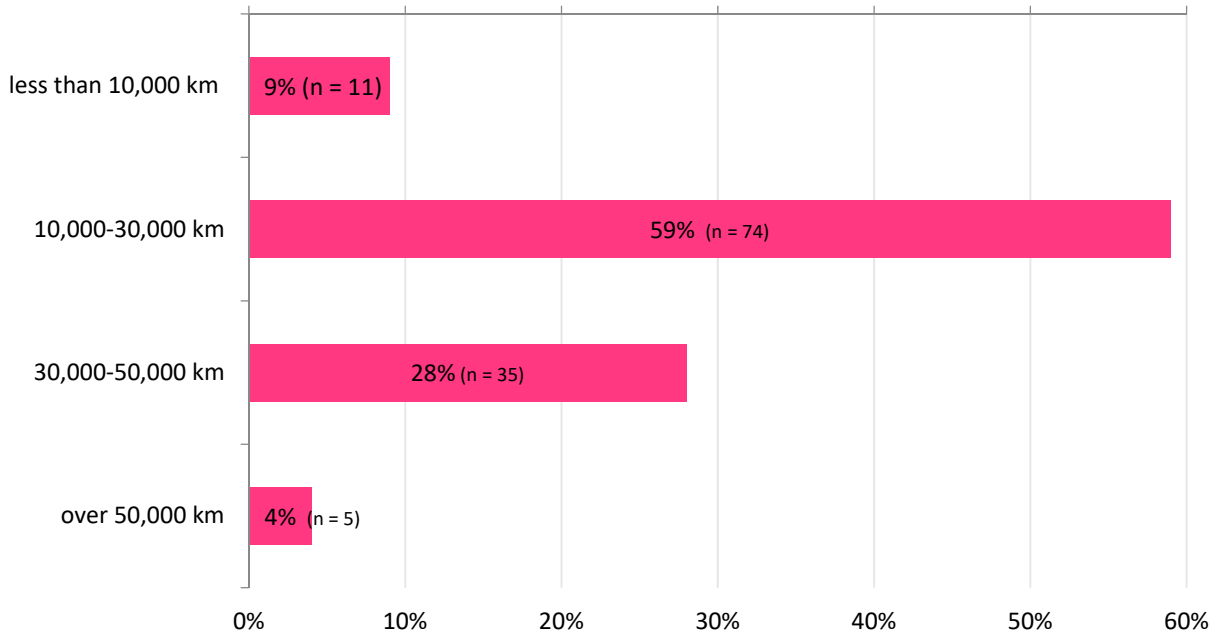
2. How often do you drive in the reindeer husbandry area?
Number of respondents: 125



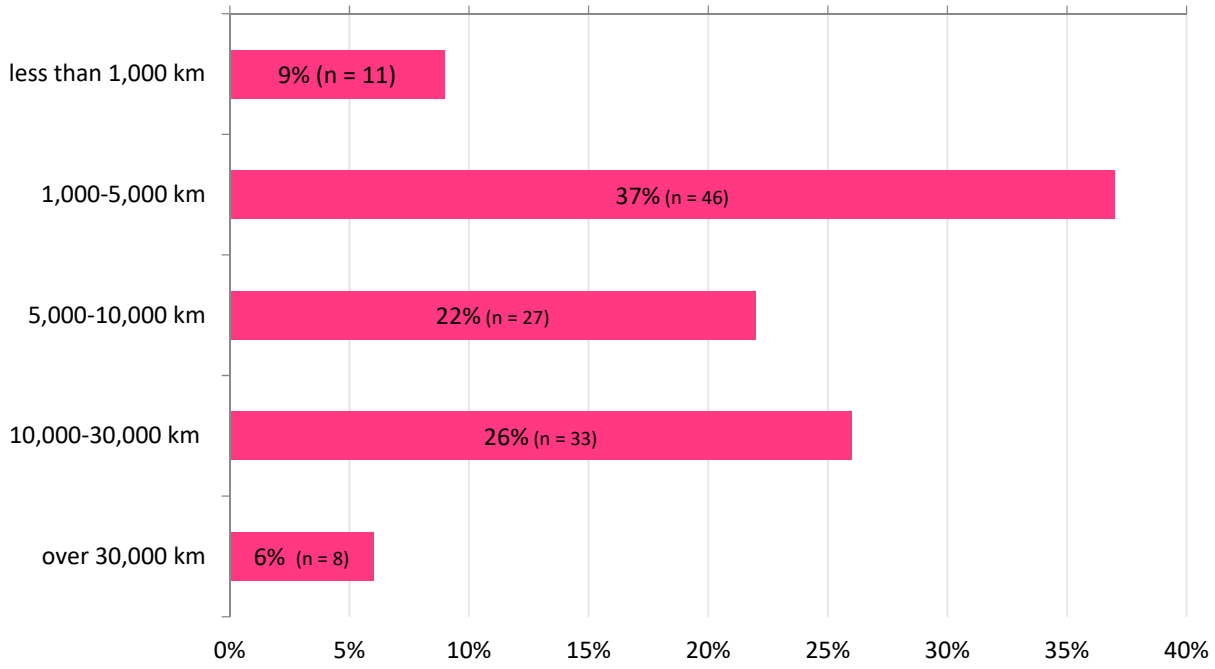
3. Do you or your family members own reindeer?
Number of respondents: 125



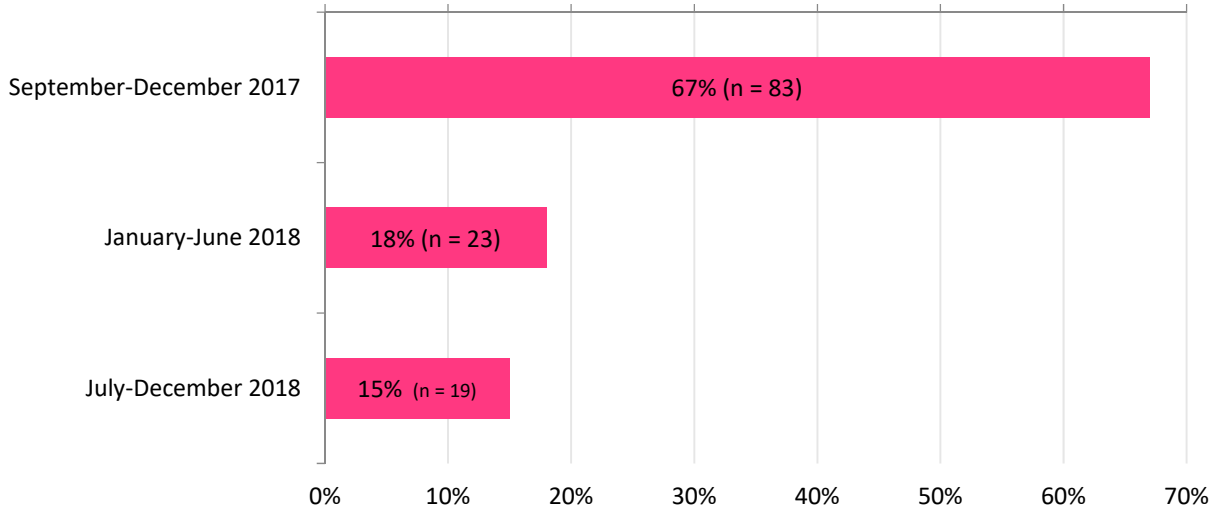
4. On average, how many kilometres do you drive per year?
Number of respondents: 125



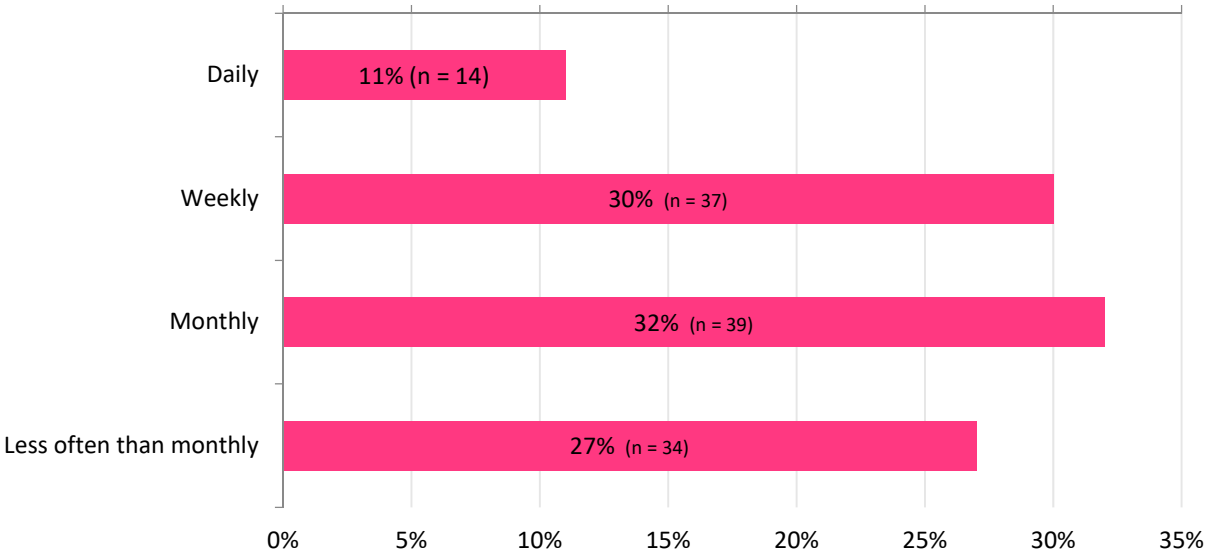
5. How many kilometres do you drive using the Porokello service in the reindeer husbandry area per year?
Number of respondents: 125



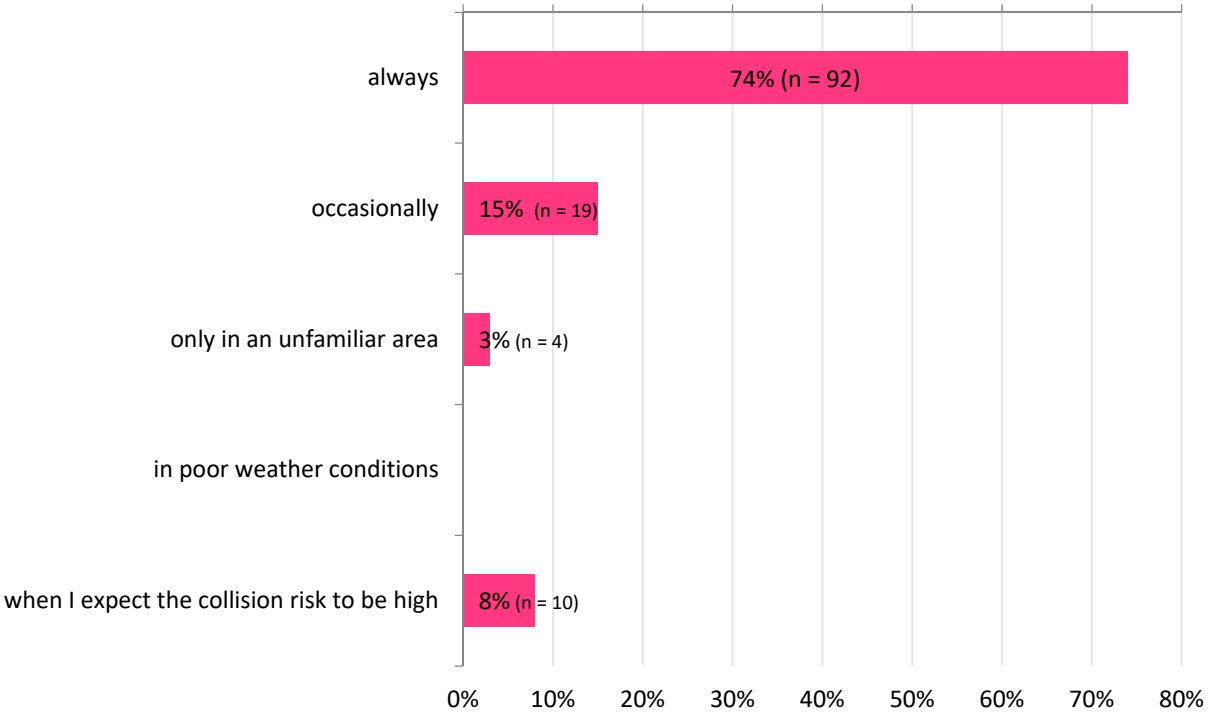
6. When did you start to use the Porokello application?
Number of respondents: 125



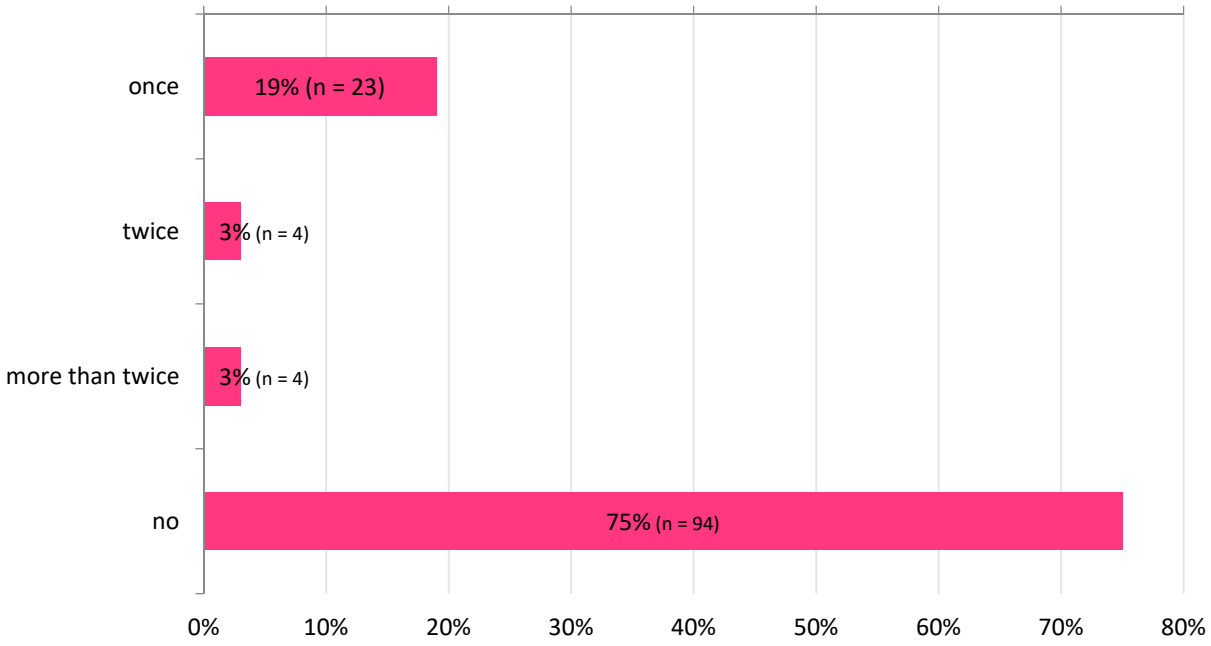
7. Do you use the application
Number of respondents: 124



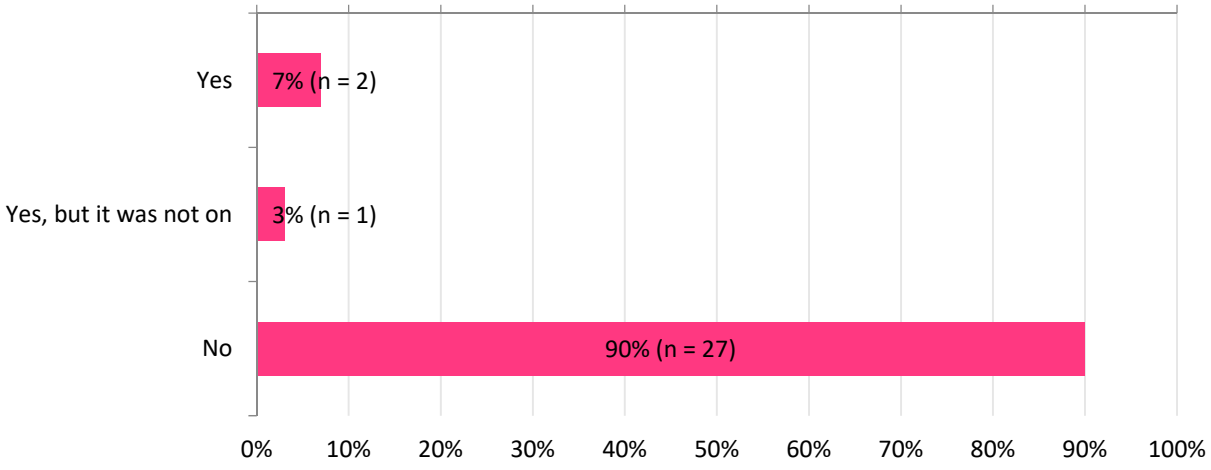
8. How often do you have the Porokello app on while driving in the reindeer husbandry area?
Number of respondents: 125



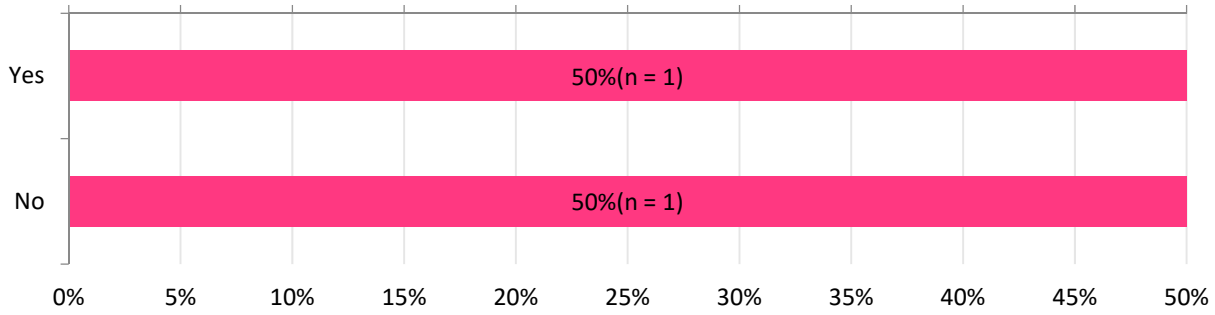
9. Have you been involved in a reindeer collision?
Number of respondents: 125



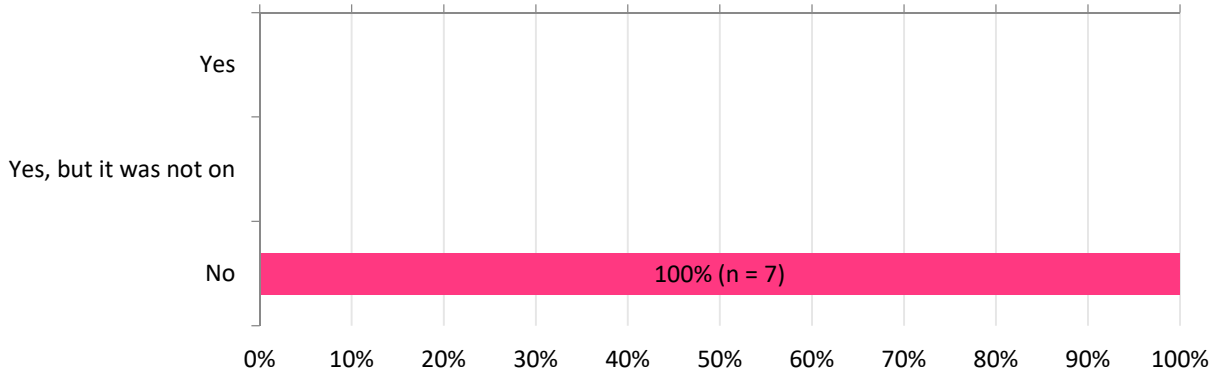
10. Did you use the Porokello service at the time? (collision 1)
Number of respondents: 30



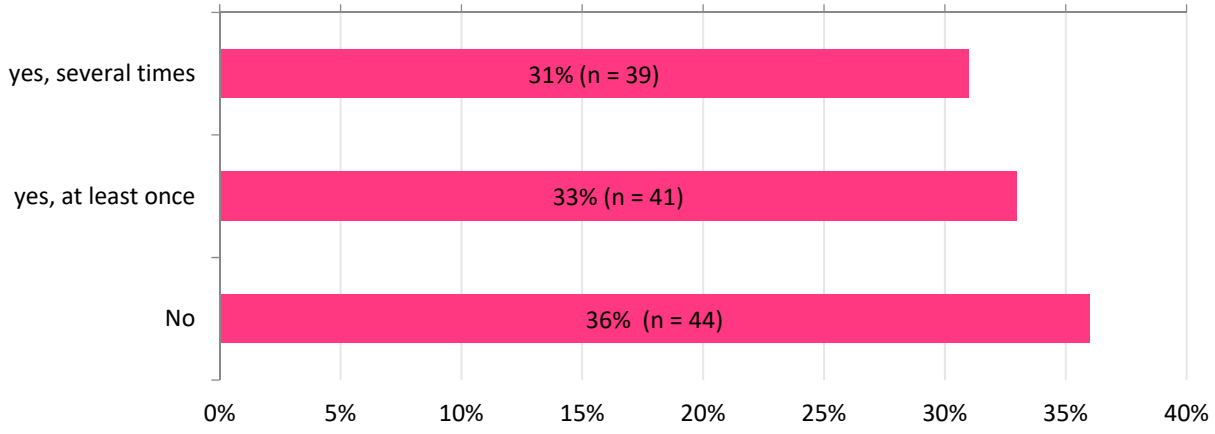
11. Did you receive a warning?
Number of respondents: 2



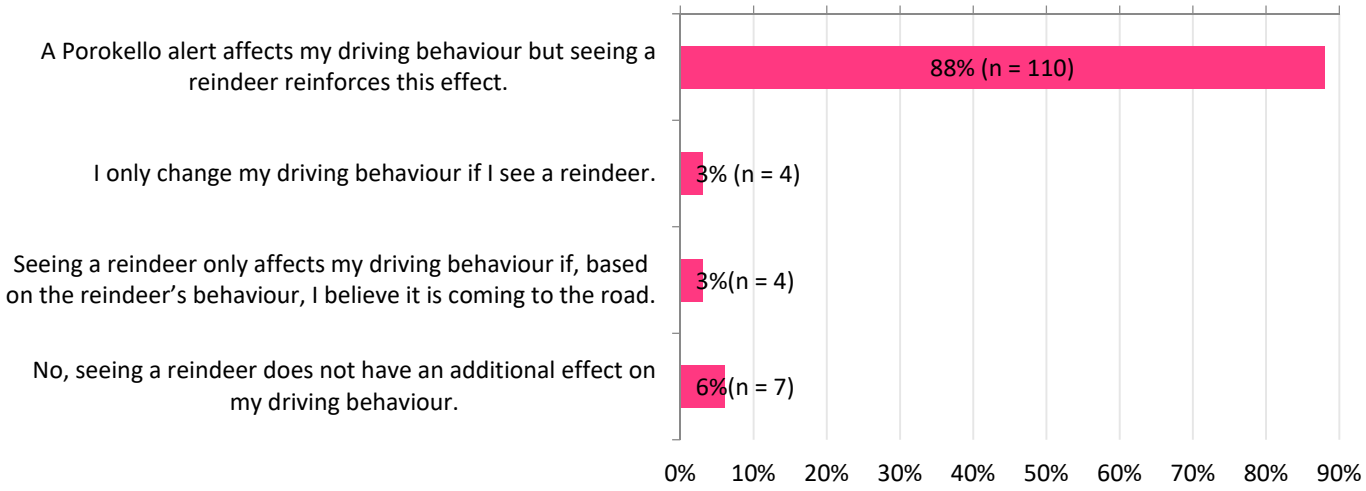
12. Did you use the Porokello service at the time? (collision 2)
Number of respondents: 7



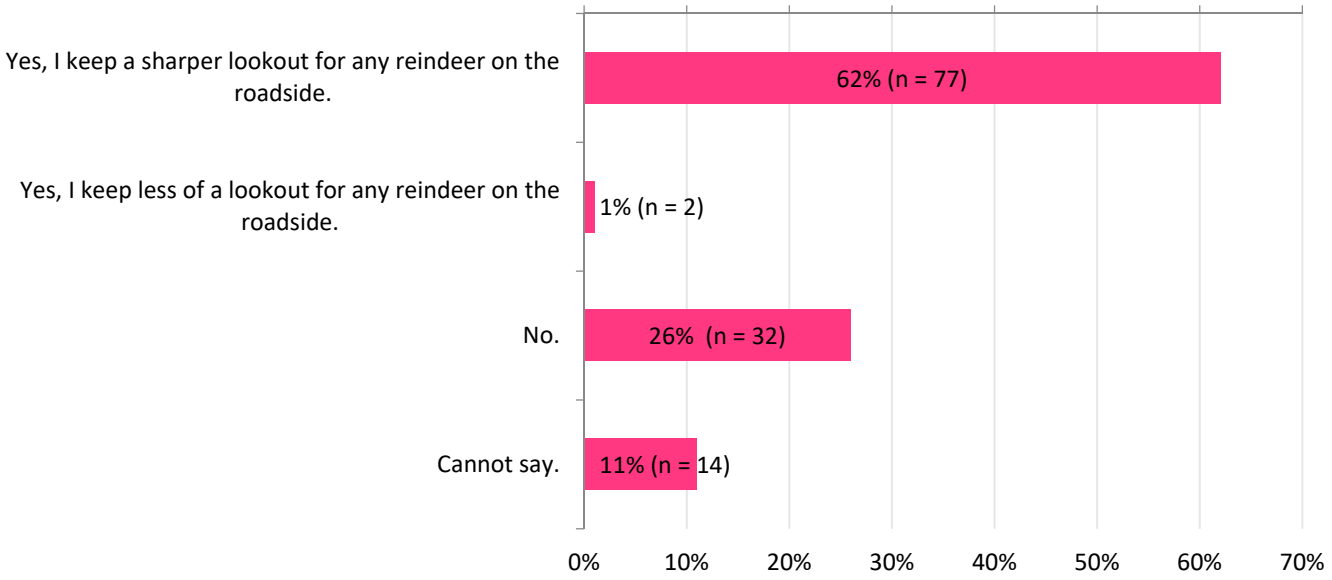
14. Have you possibly avoided a collision with the help of Porokello?
Number of respondents: 124



15. Does seeing a reindeer in the alert area have an additional effect on your driving behaviour?
Number of respondents: 125

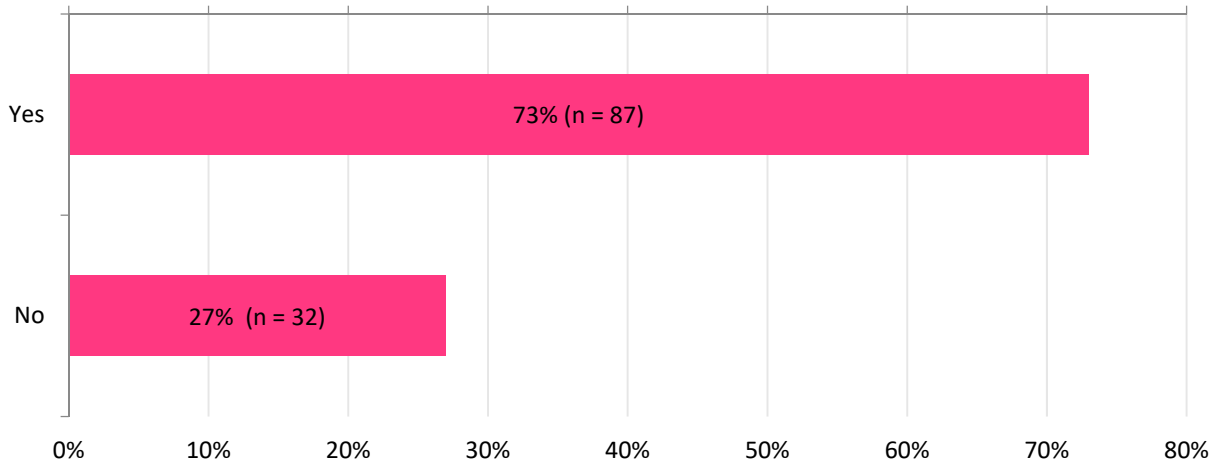


16. Does Porokello affect on how much you keep a lookout for any reindeer in general (when the alert is not on)?
Number of respondents: 125

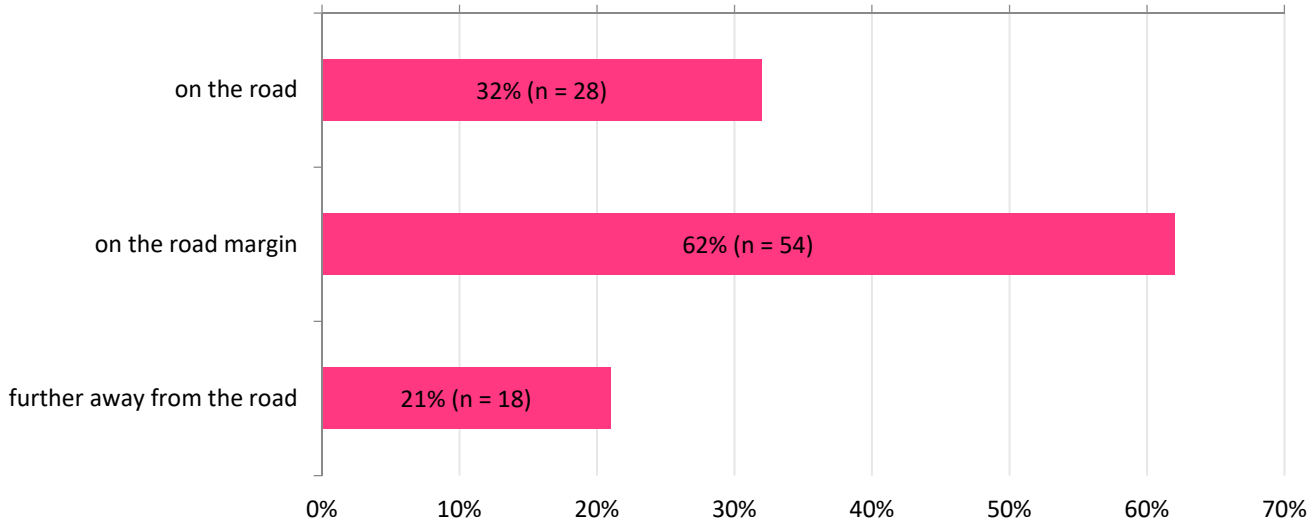


Think about the last time you received a Porokello alert. When did this occur? Did you see reindeer? Answer the following questions based on this incident.

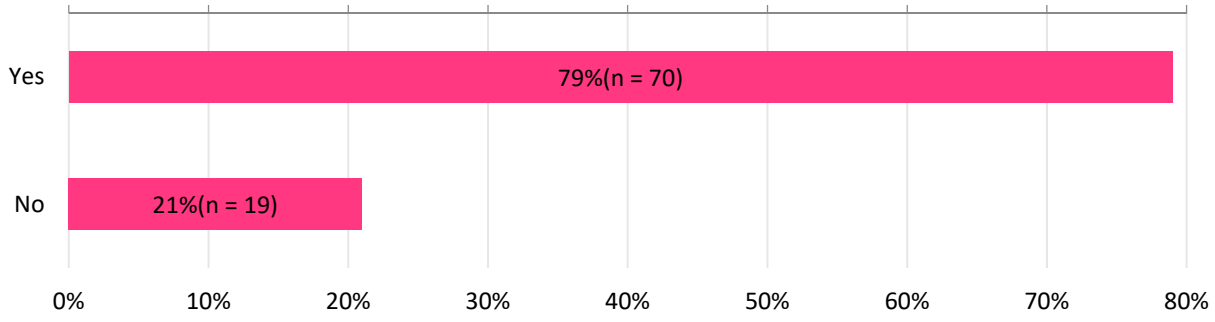
17. I noticed reindeer in the alert area
Number of respondents: 119



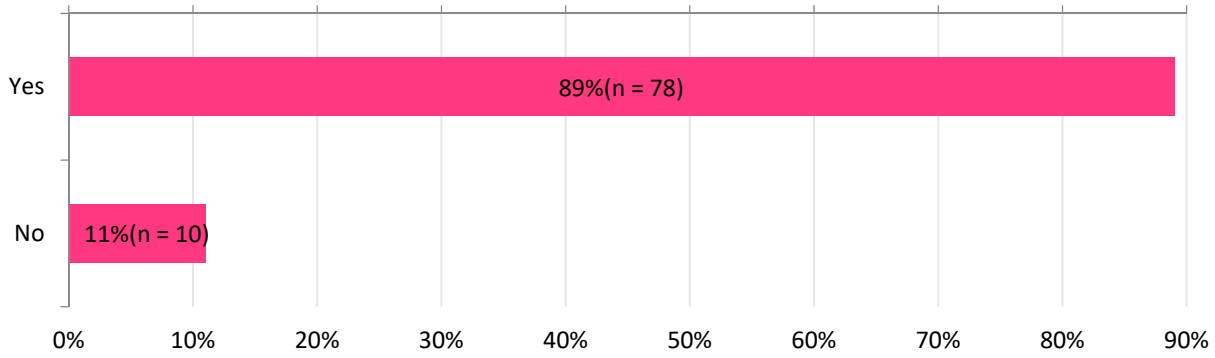
18. The reindeer in the alert area were:
Number of respondents: 87, Number of chosen answers: 100



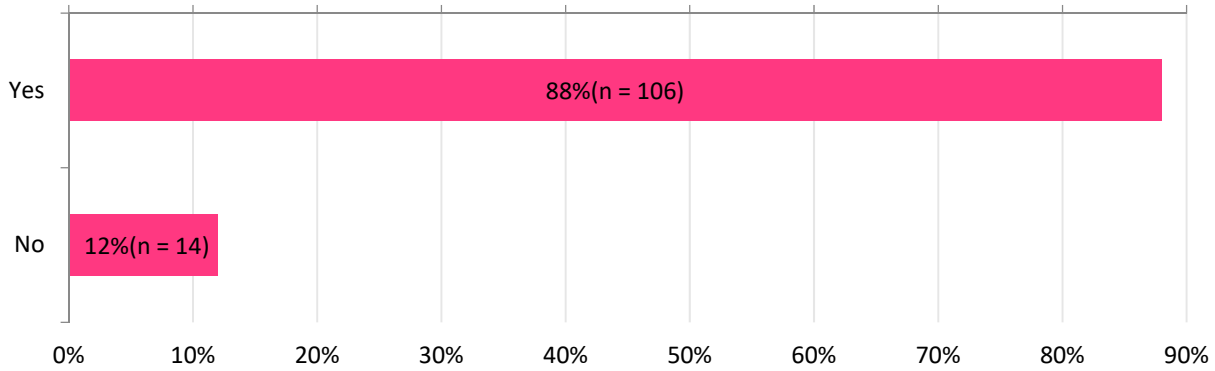
19. I would have noticed the reindeer also without the alert
Number of respondents: 89



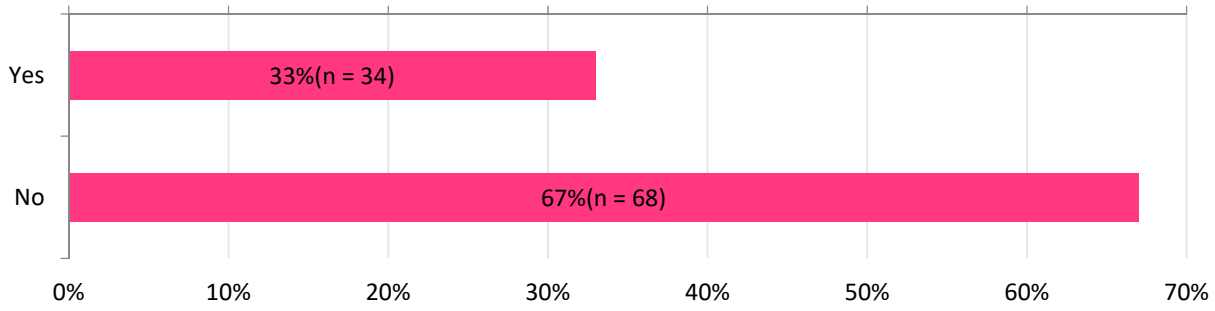
20. Because of the alert, I noticed the reindeer earlier than I would have done without the alert
Number of respondents: 88



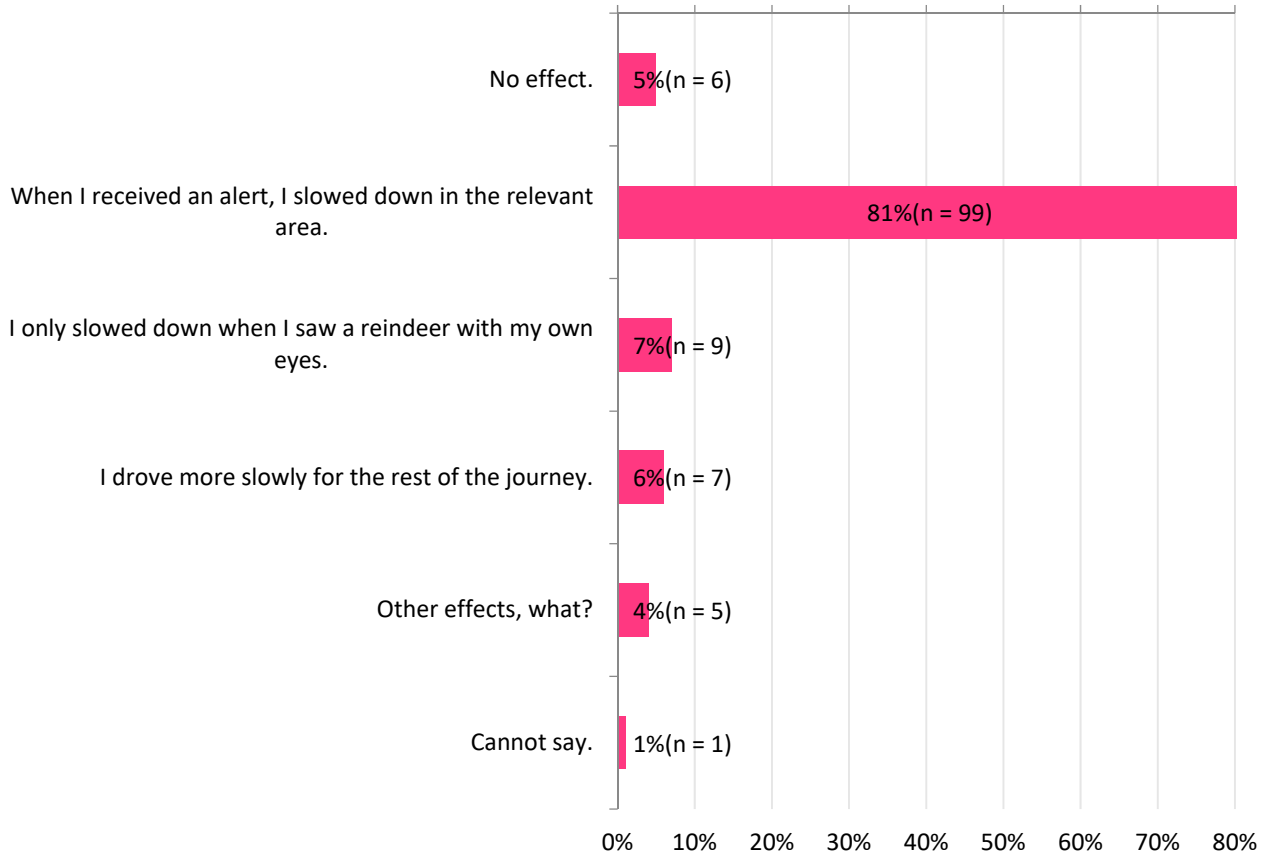
21. I got prepared and changed my driving behaviour after receiving the reindeer alert
Number of respondents: 120



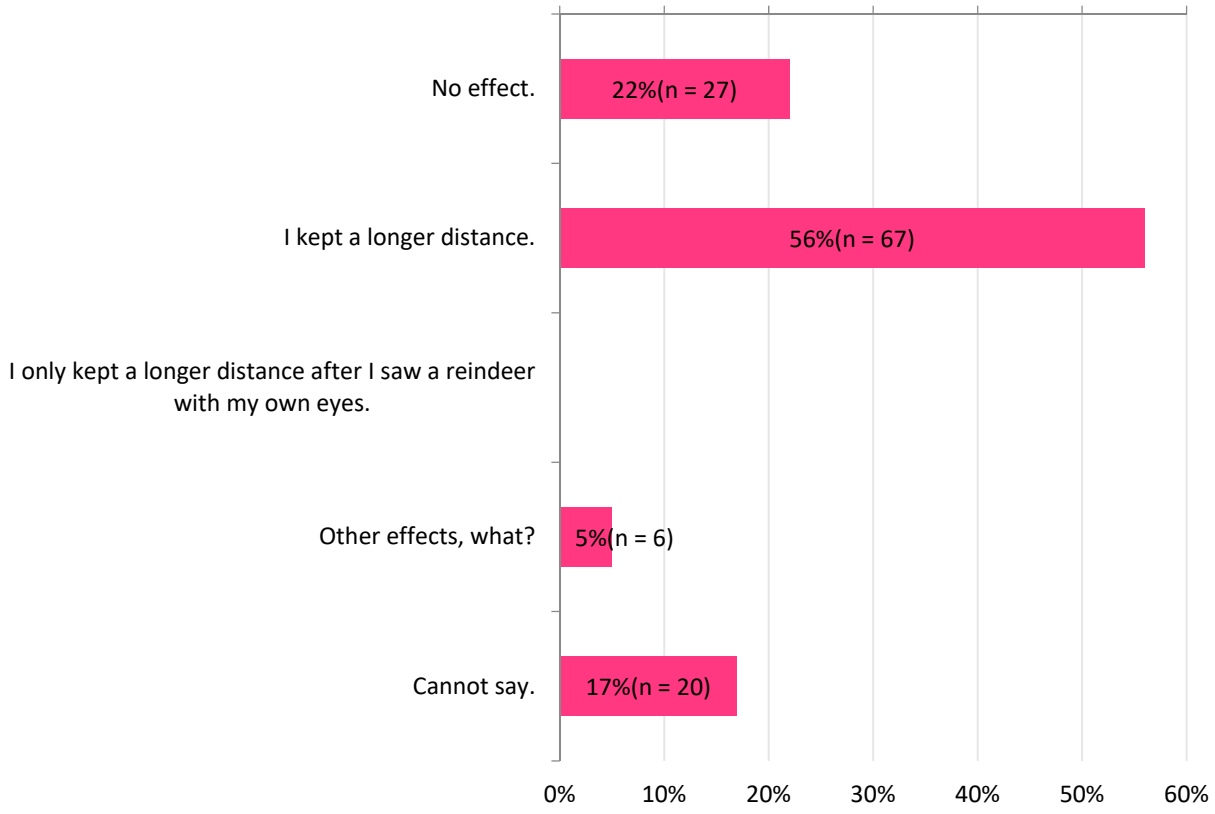
22. I avoided a collision because of the alert
Number of respondents: 102



23. DRIVING SPEED
How did the alert affect your driving speed?
Number of respondents: 122, Number of chosen answers: 127



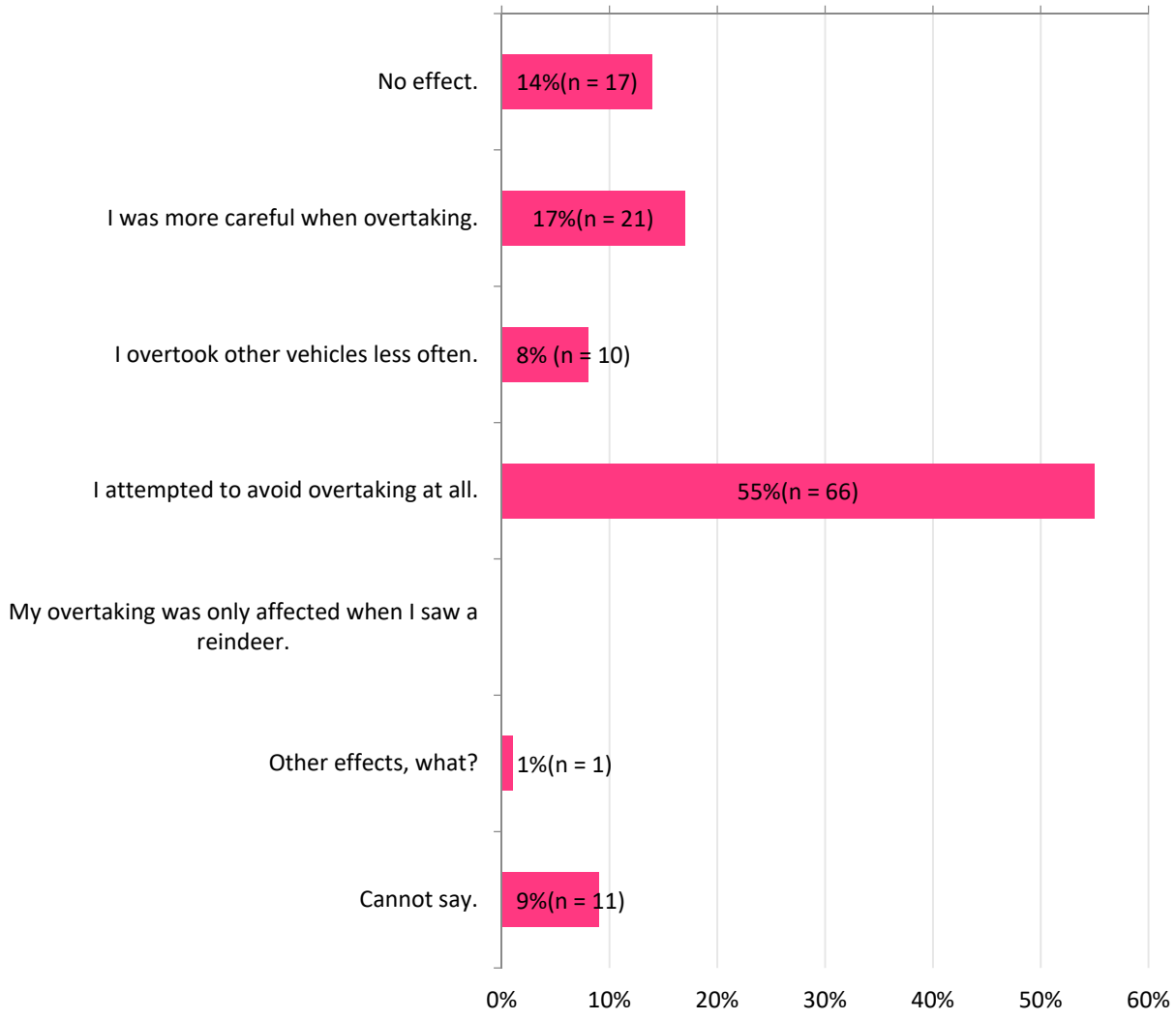
24. DISTANCE TO THE VEHICLE AHEAD
How did the alert affect to this distance?
Number of respondents: 120



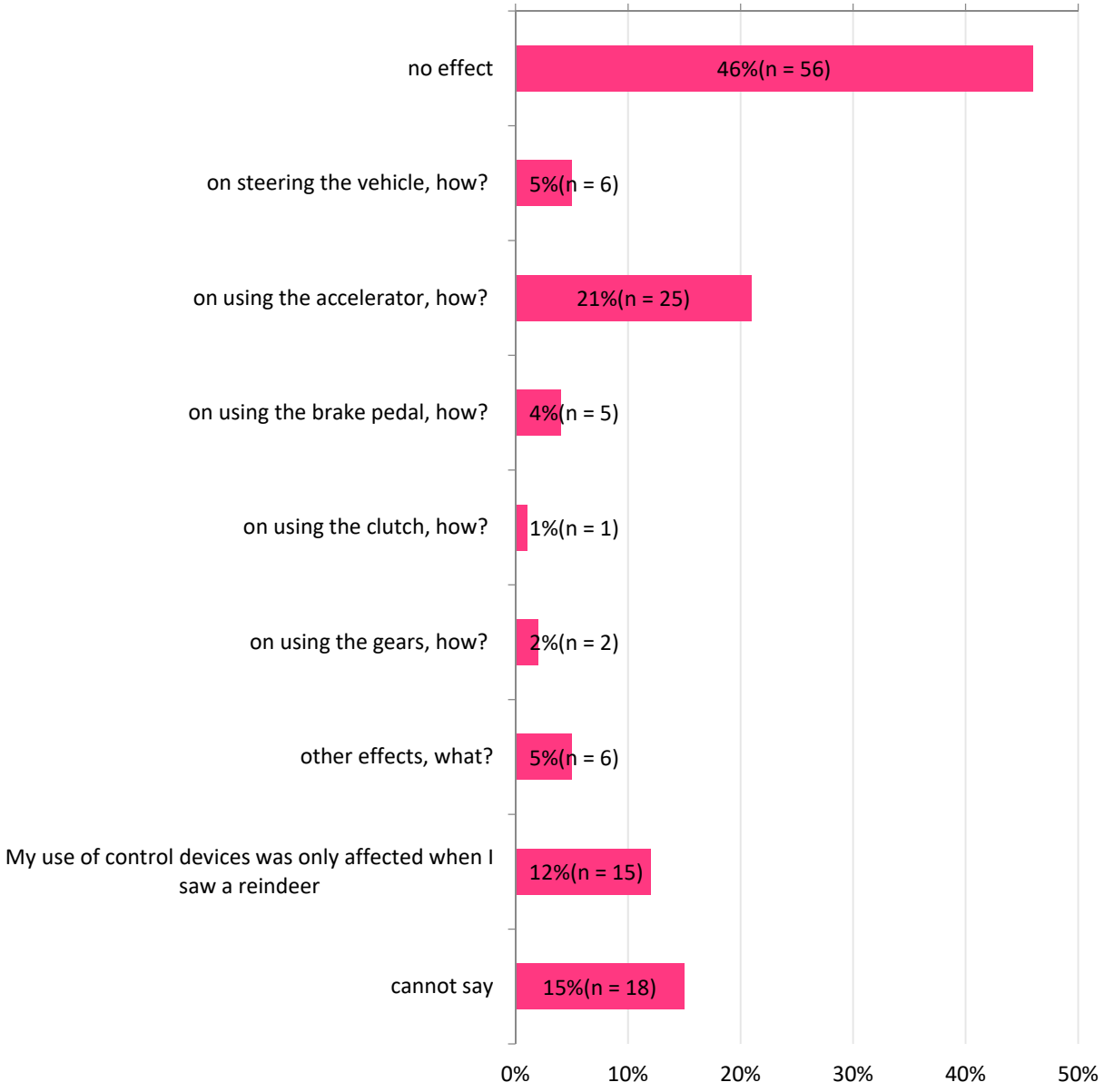
25. OVERTAKING

How did the alert affect on your overtaking behaviour?

Number of respondents: 121, Number of chosen answers: 126

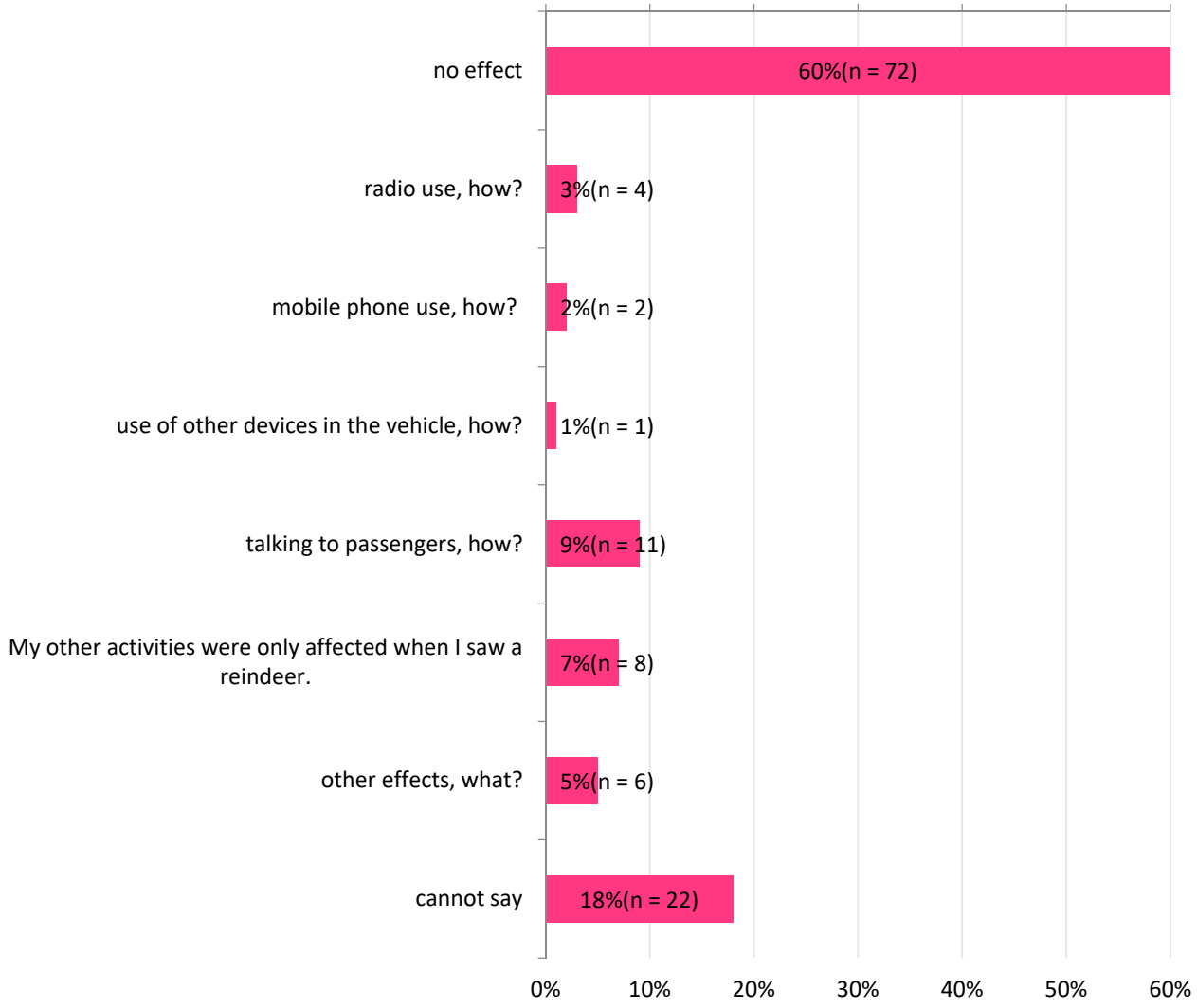


26. USE OF CONTROL DEVICES: How did the alert affect your use of control devices (steering wheel, pedals, gears, other electronic devices)?
Number of respondents: 121, Number of chosen answers: 134



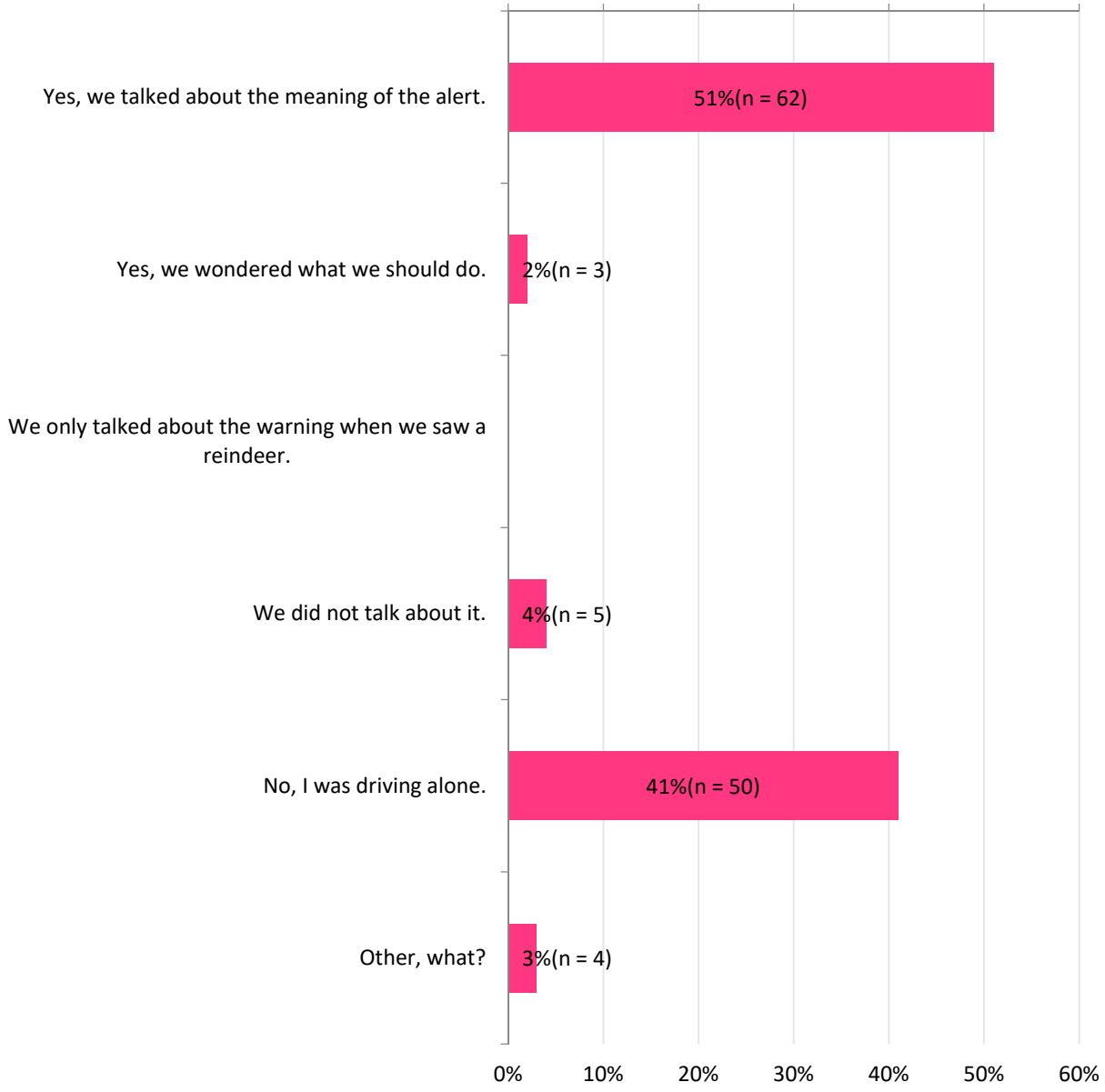
27. ACTIVITIES PERFORMED WHILE DRIVING

How did the alert affect on the activities performed while driving?
Number of respondents: 121, Number of chosen answers: 126



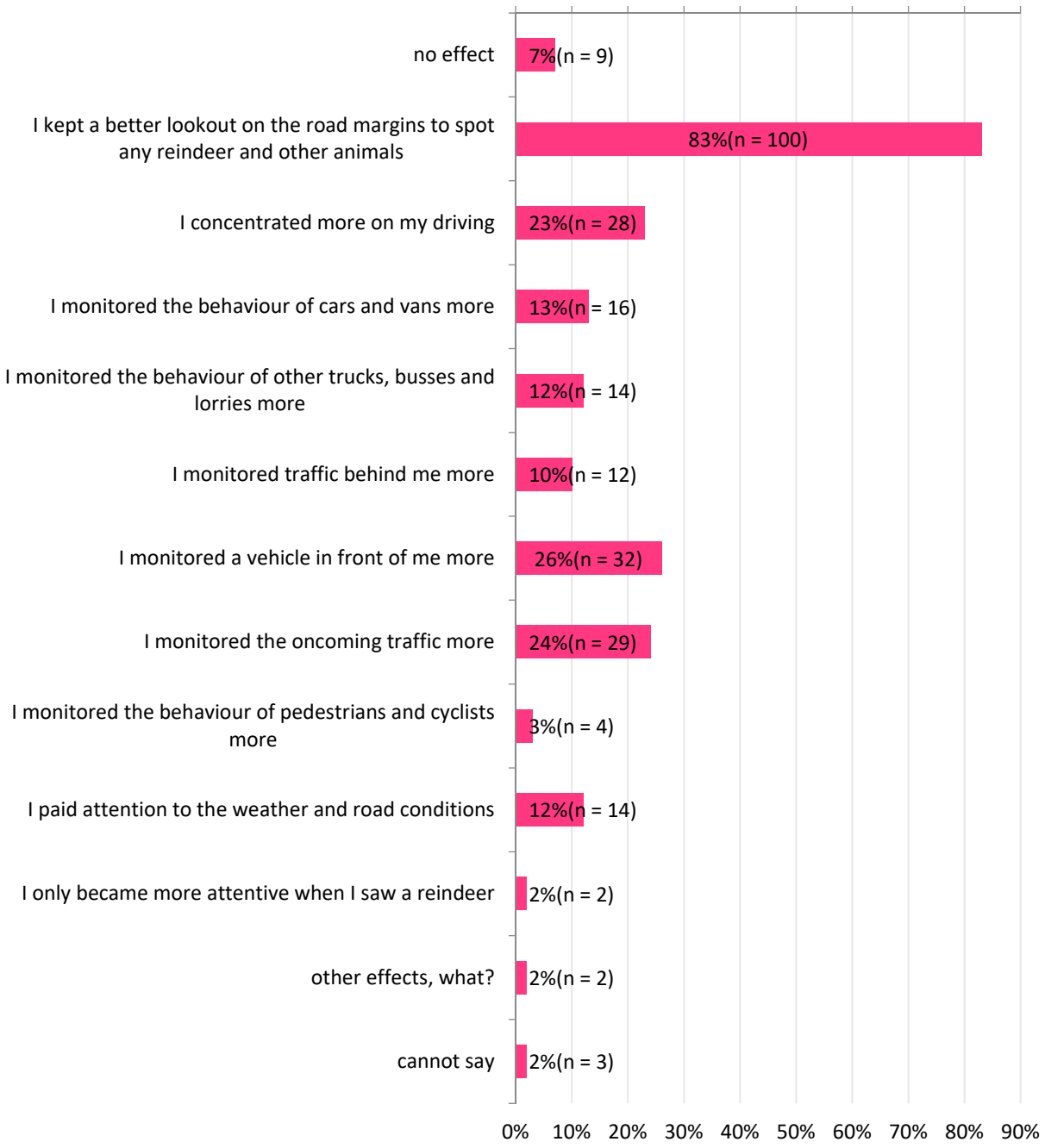
28. TALKING ABOUT THE ALERT

If you had a passenger, did you discuss the alert after receiving it?
Number of respondents: 121, Number of chosen answers: 124



29. FOCUSING ATTENTION

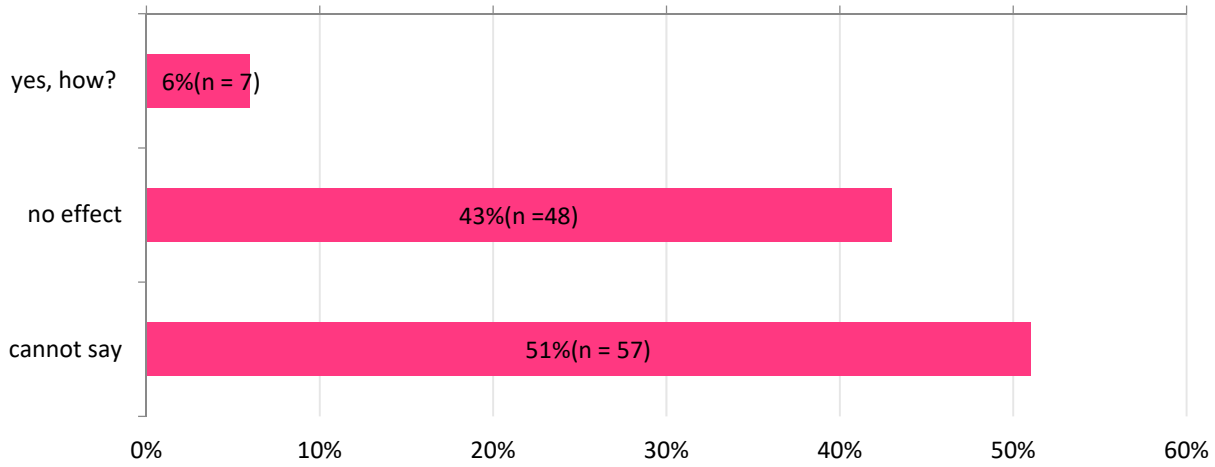
How did the alert affect the way you focused your attention (what kind of information did you seek for in the traffic environment)?
Number of respondents: 121, Number of chosen answers: 265



30. OTHER IMPACTS

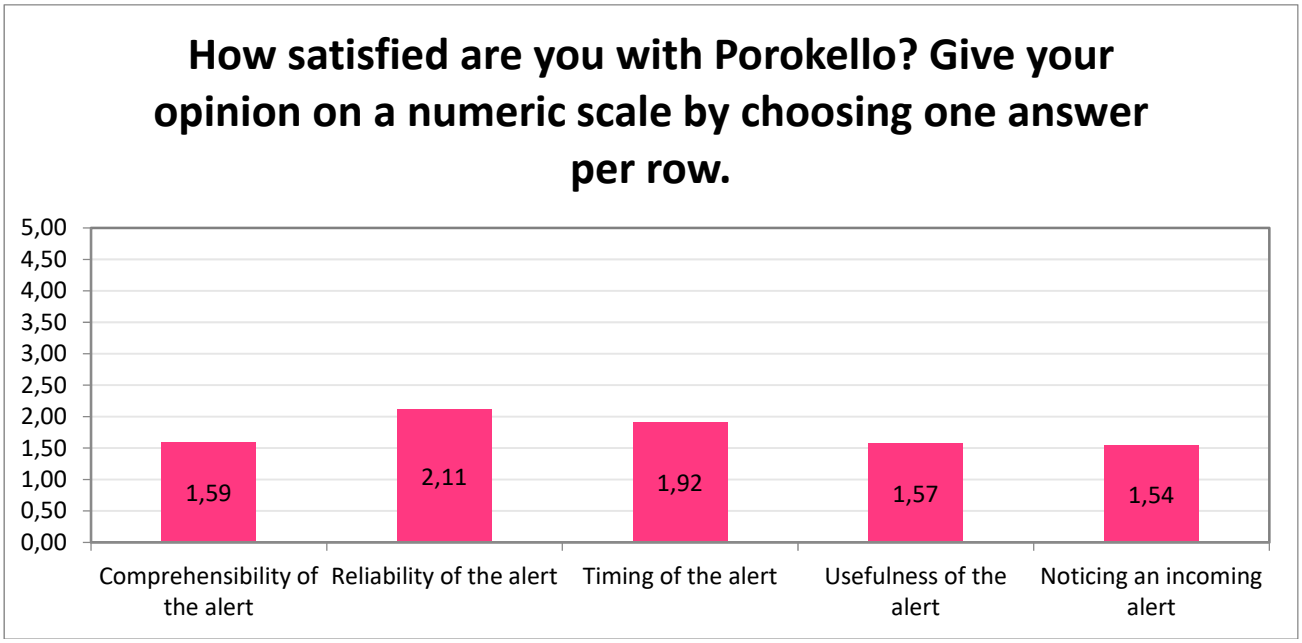
Did receiving the alert have any other impacts?

Number of respondents: 112

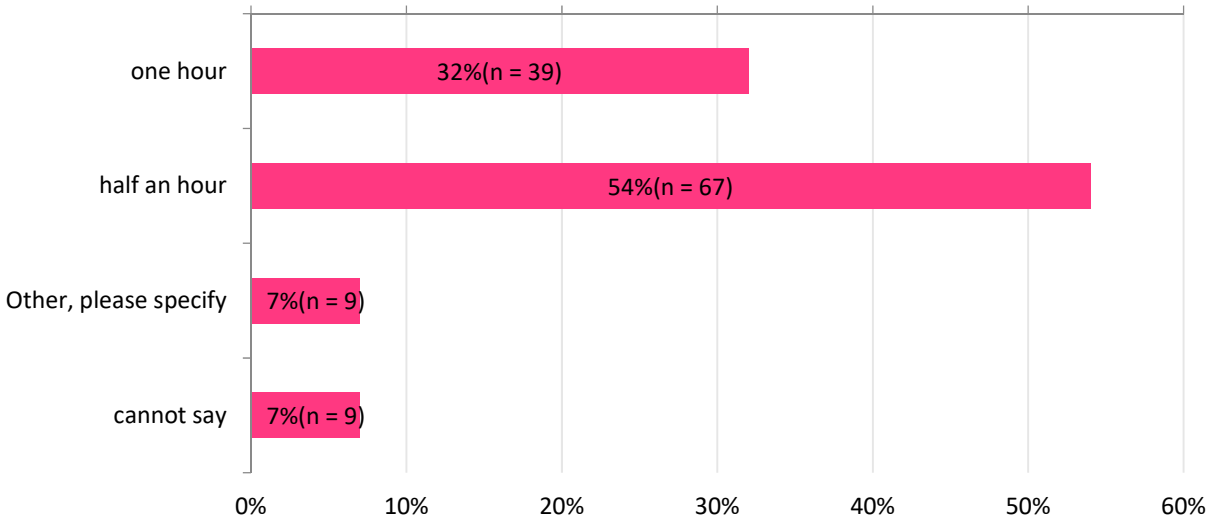


31. How satisfied are you with Porokello? Give your opinion on a numeric scale by choosing one answer per row.

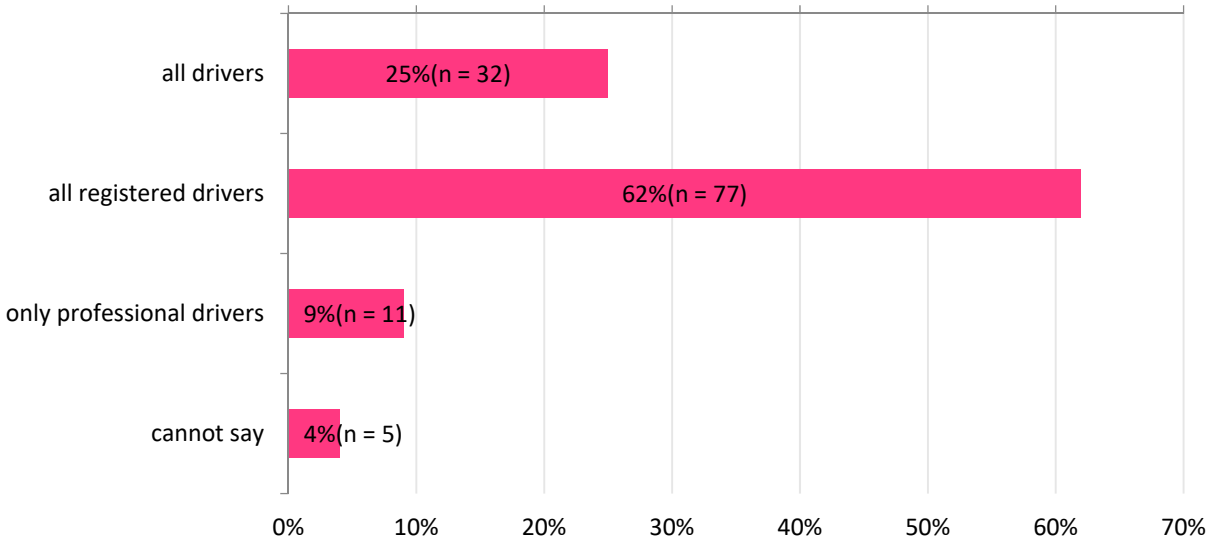
Number of respondents: 123



34. A Porokello alert is currently valid for half an hour. Until June 2018, the validity period was one hour. How long should a Porokello alert be valid?
Number of respondents: 124



35. Who should be able to give Porokello warnings?
Number of respondents: 125

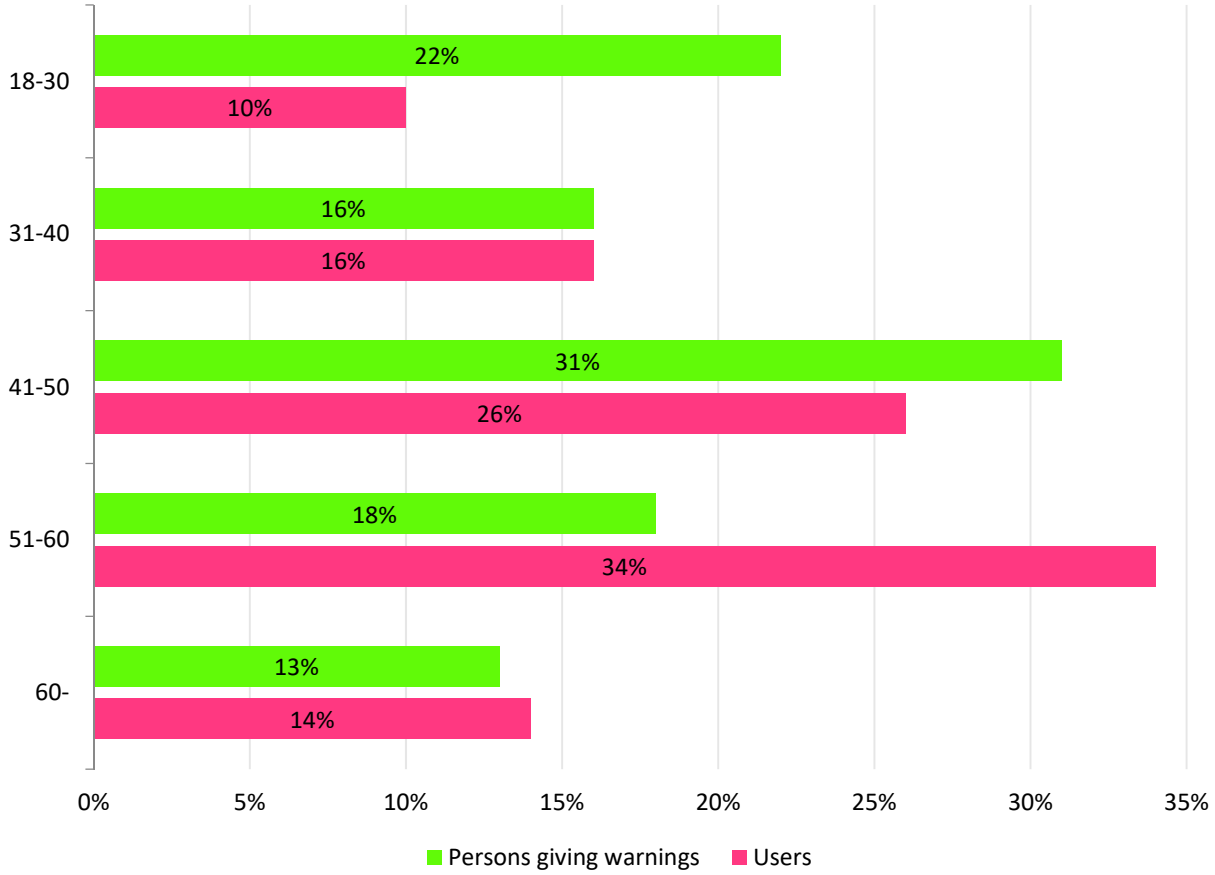


Appendix 5. Questionnaire results, combined (persons giving warnings and users)

Name of report: Combined reports PERSONS GIVING WARNINGS AND USERS
Headline of report: Impact evaluation of the Porokello alert service

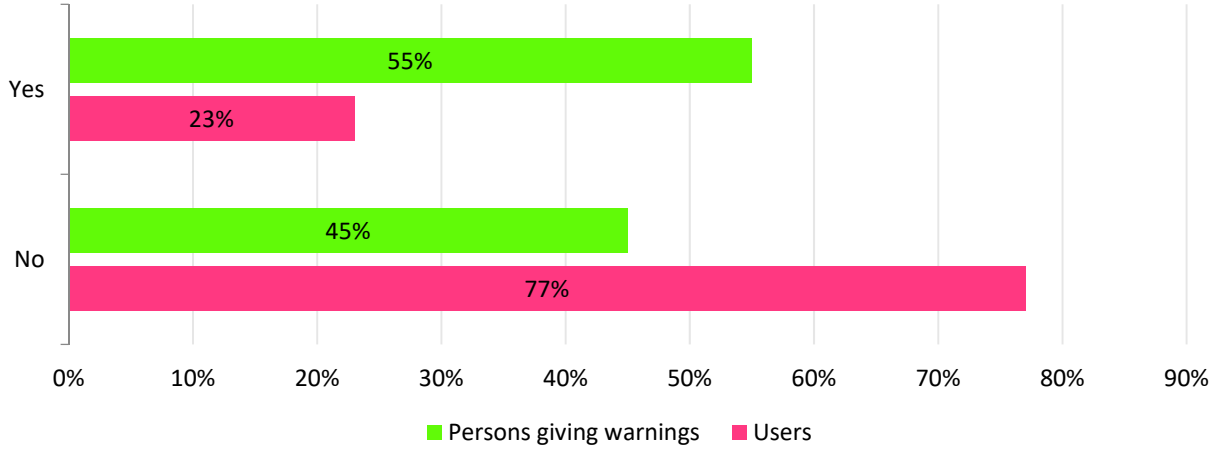
Total number of respondents: 180

1. Your age?
Number of respondents: 173



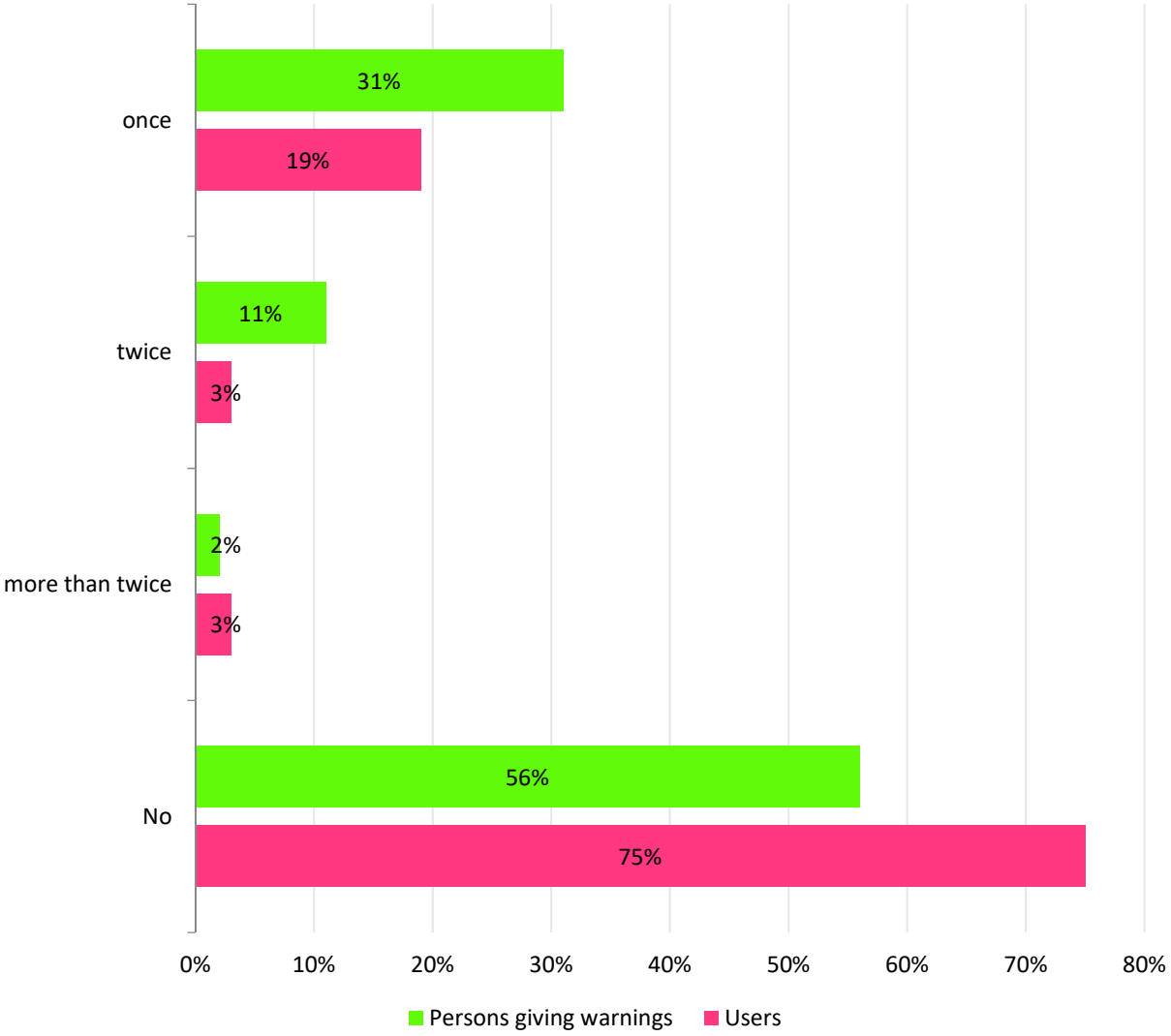
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
18-30	12	21,82%	12	10,17%
31-40	9	16,36%	19	16,1%
41-50	17	30,91%	30	25,42%
51-60	10	18,18%	40	33,9%
60-	7	12,73%	17	14,41%

2. Do you or your family members own reindeer?
Number of respondents: 178



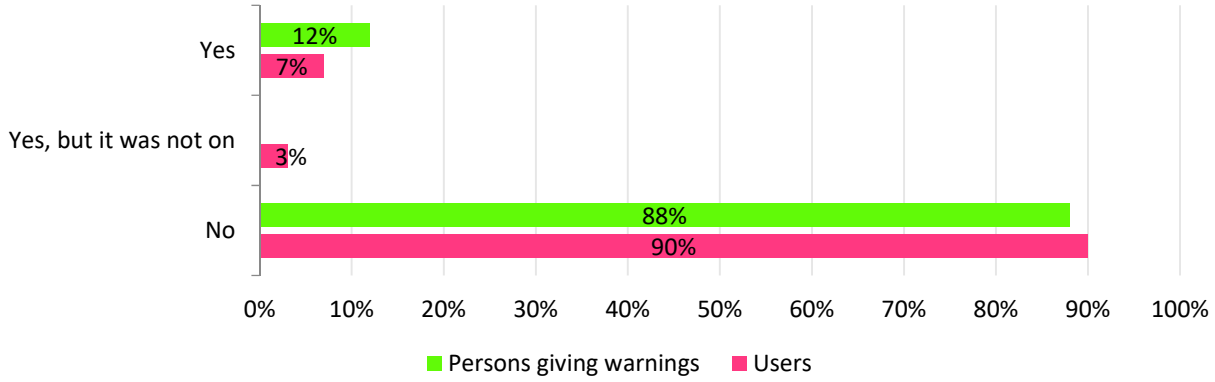
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	29	54,72%	29	23,2%
No	24	45,28%	96	76,8%

3. Have you been involved in a reindeer collision?
Number of respondents: 180



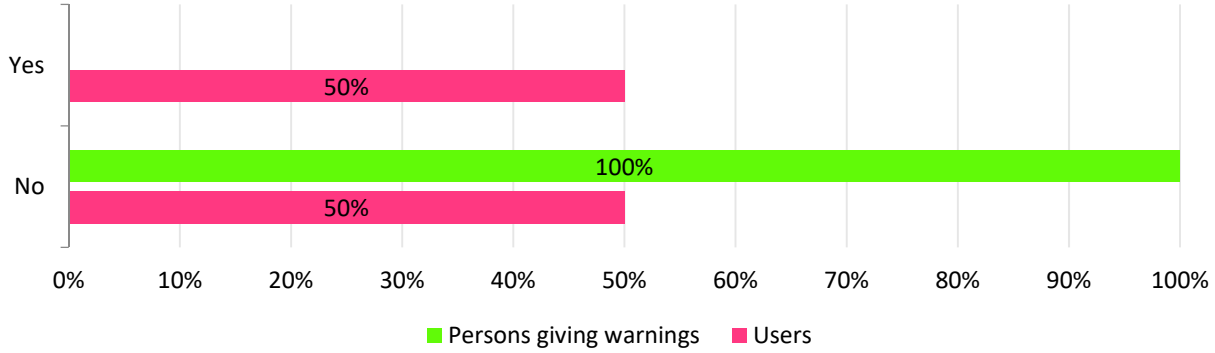
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
once	17	30,91%	23	18,4%
twice	6	10,91%	4	3,2%
more than twice	1	1,82%	4	3,2%
No	31	56,36%	94	75,2%

4. Did you use the Porokello service at the time?
Number of respondents: 54



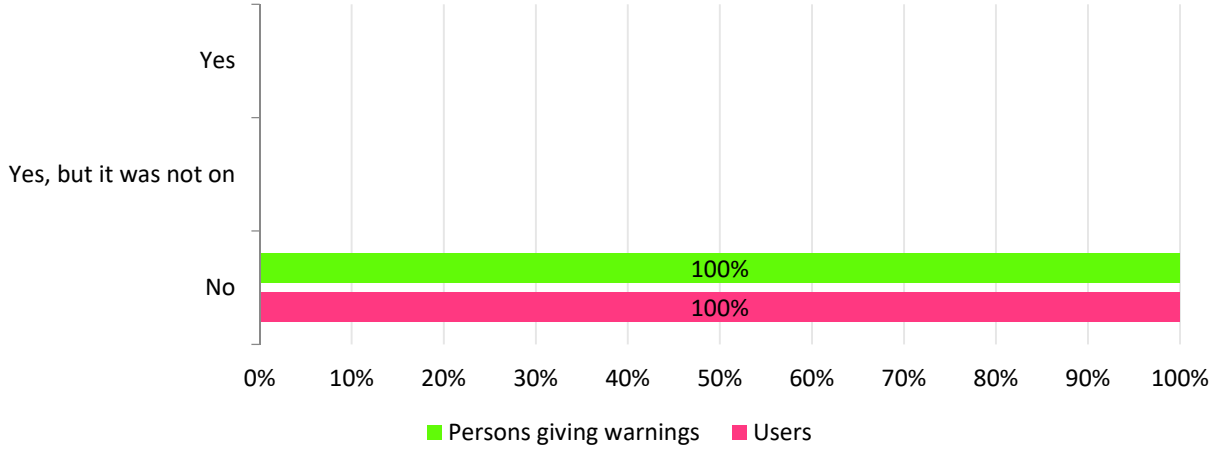
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	3	12,5%	2	6,67%
Yes, but it was not on	0	0%	1	3,33%
No	21	87,5%	27	90%

5. Did you receive an alert?
Number of respondents: 4



	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	0	0%	1	50%
No	2	100%	1	50%

6. Did you use the Porokello service at the time?
Number of respondents: 13

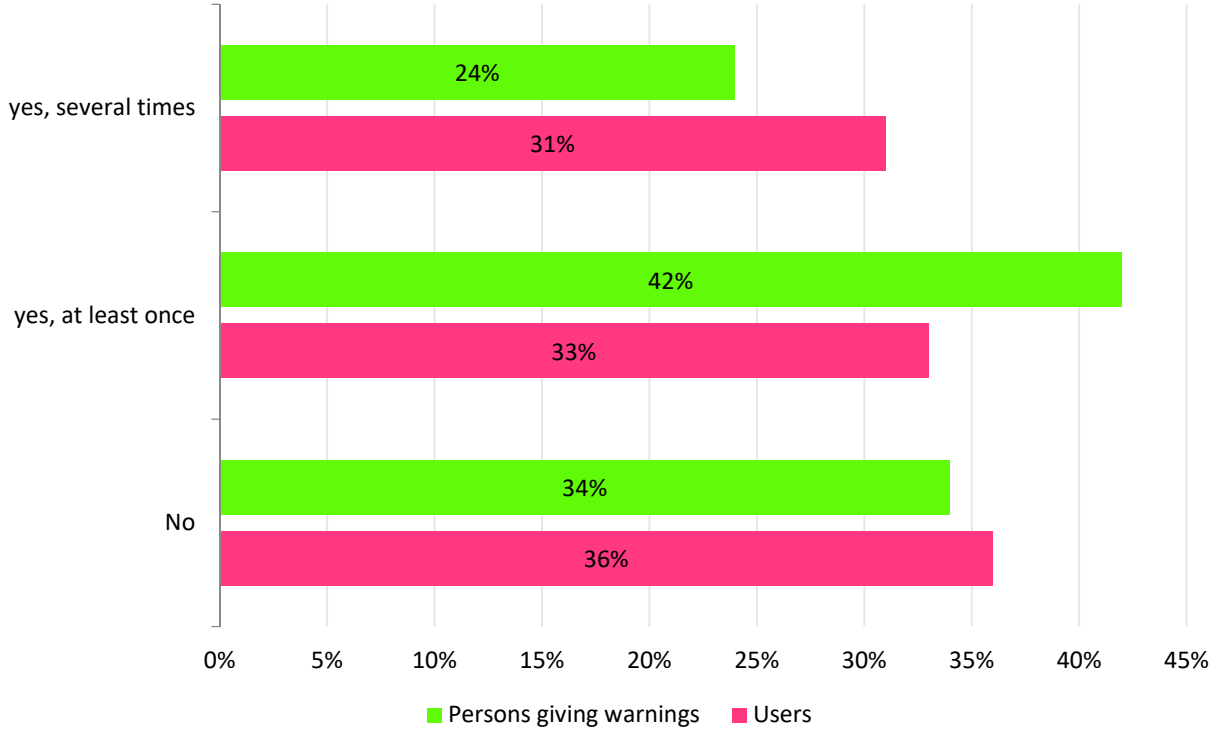


	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	0	0%	0	0%
Yes, but it was not on	0	0%	0	0%
No	6	100%	7	100%

7. Did you receive an alert?
Number of respondents: 0

	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	0	0%	0	0%
No	0	0%	0	0%

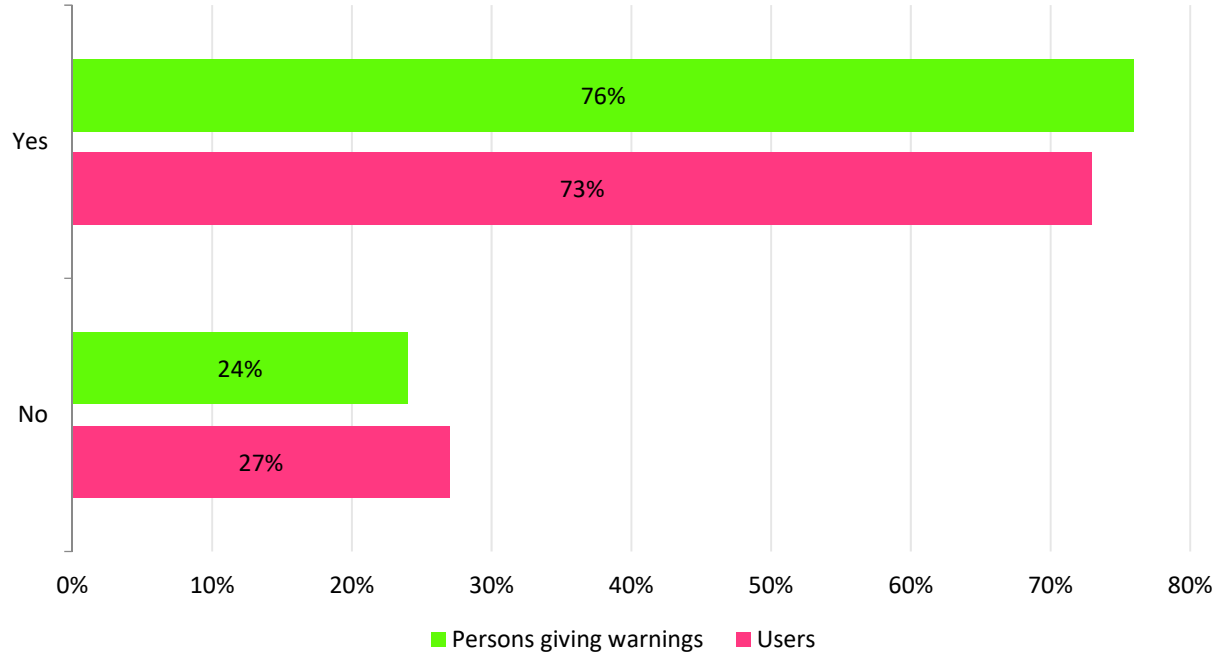
8. Have you possibly avoided a collision with the help of Porokello?
Number of respondents: 179



	Persons giving warnings		Users	
	n	Per cent	n	Per cent
yes, several times	13	23,64%	39	31,45%
yes, at least once	23	41,82%	41	33,07%
No	19	34,54%	44	35,48%

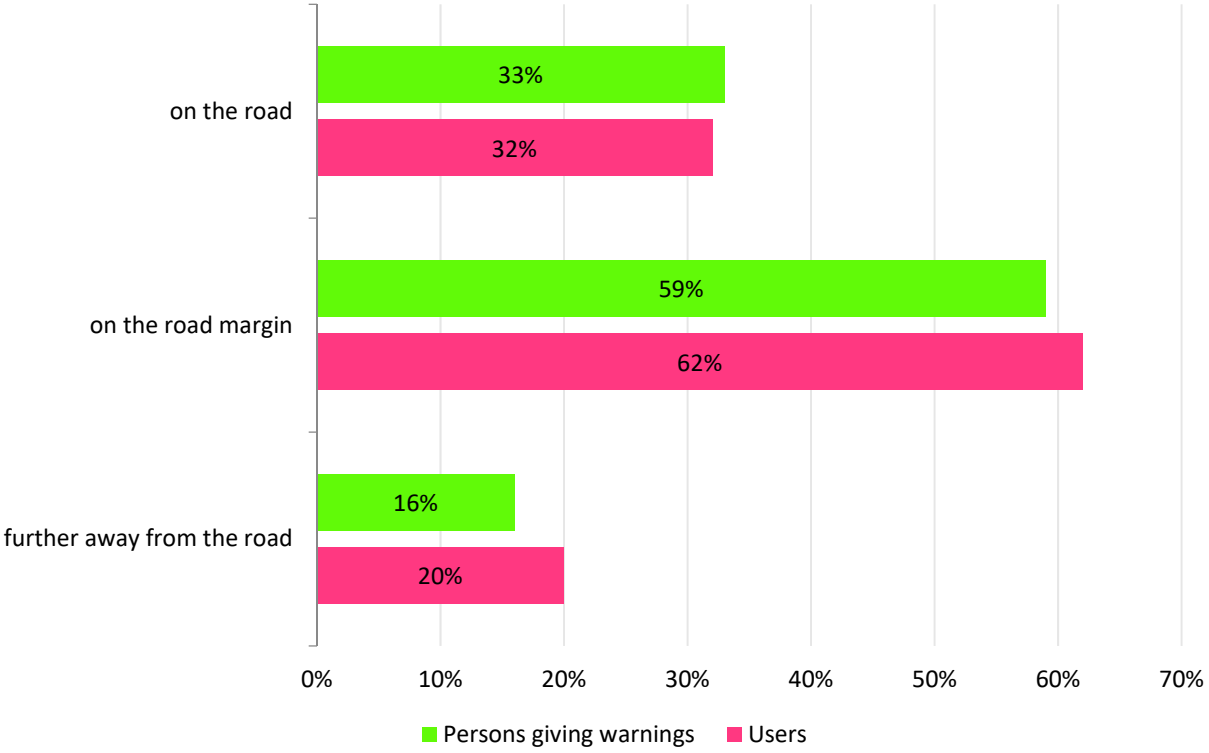
Think about the last time you received a Porokello alert. When did this occur? Did you see reindeer? Answer the following questions based on this incident.

9. I noticed reindeer in the alert area
Number of respondents: 173



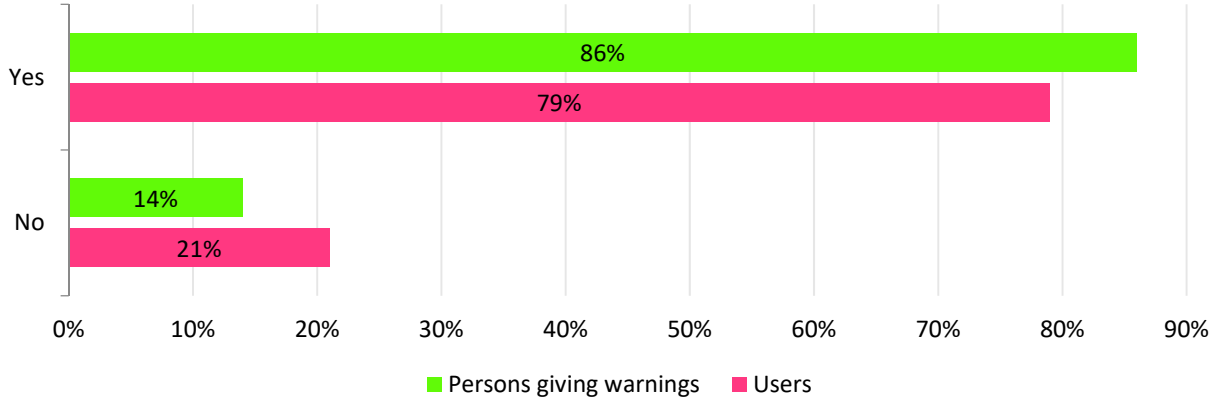
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	41	75,93%	87	73,11%
No	13	24,07%	32	26,89%

10. The reindeer in the alert area were:
Number of respondents: 129, Number of chosen answers: 146



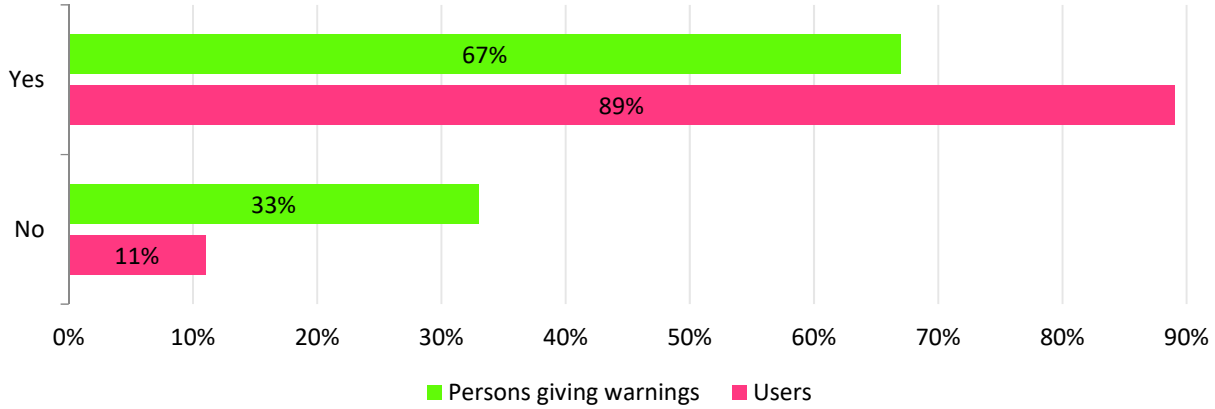
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
on the road	14	33,33%	28	32,18%
on the road margin	25	59,52%	54	62,07%
further away from the road	7	16,67%	18	20,69%

11. I would have noticed the reindeer also without the alert
Number of respondents: 131



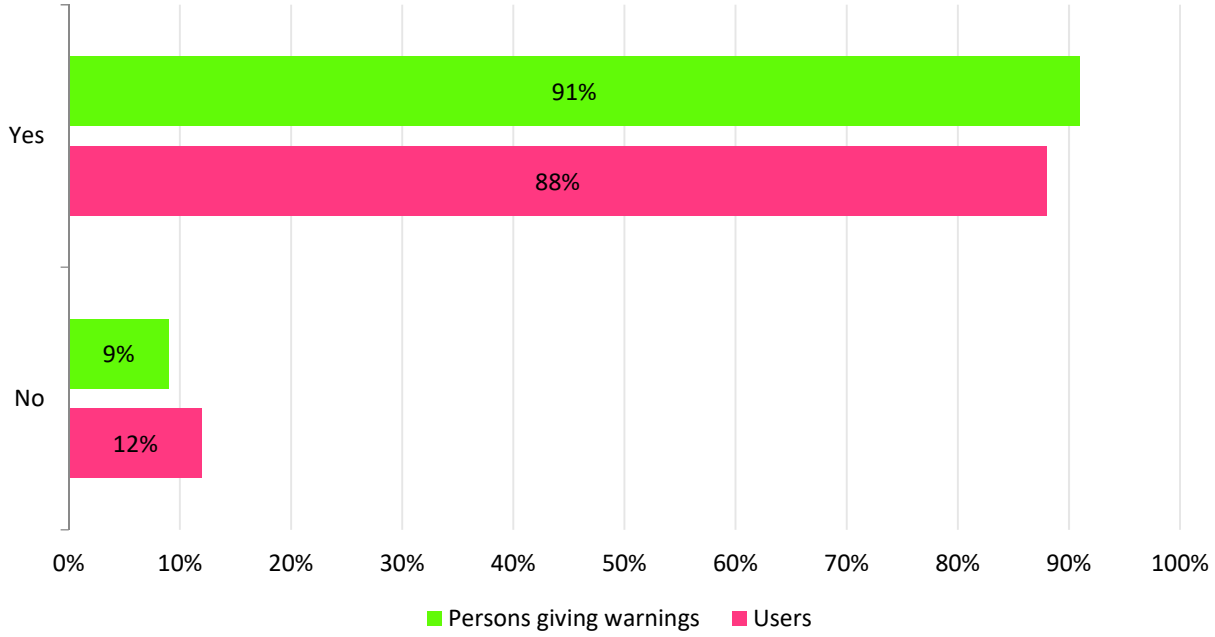
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	36	85,71%	70	78,65%
No	6	14,29%	19	21,35%

12. Because of the alert, I noticed the reindeer earlier than I would have done without the alert
Number of respondents: 130



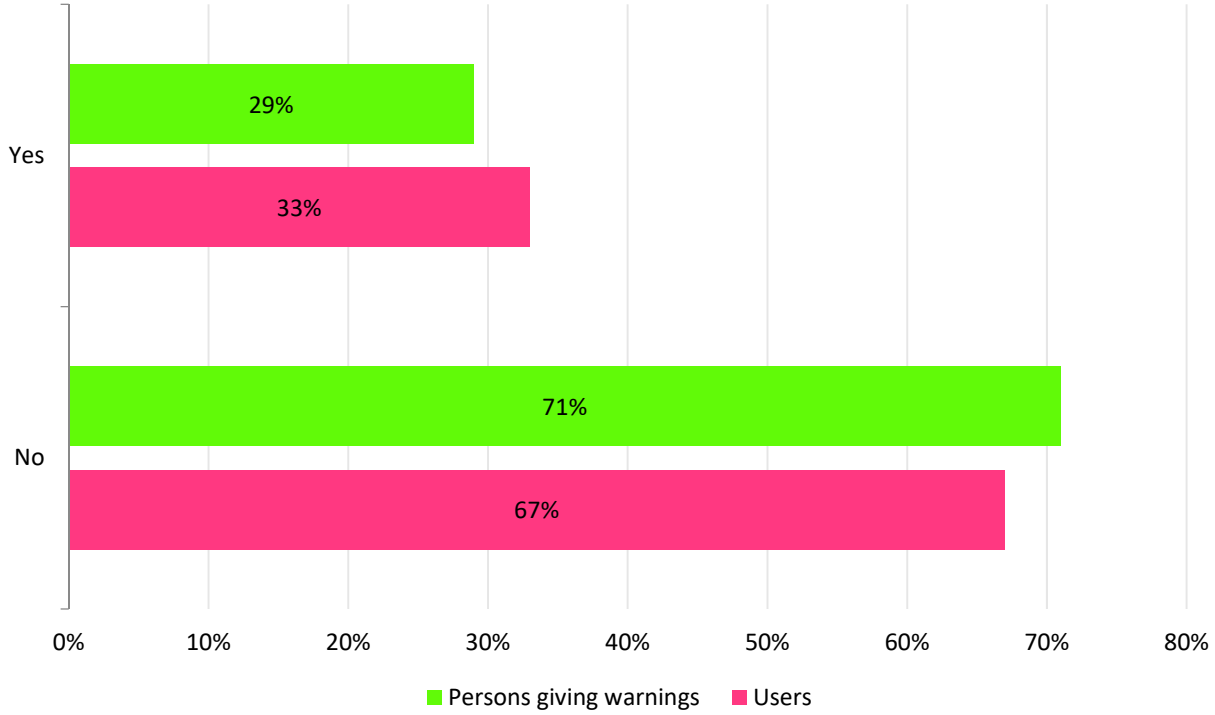
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	28	66,67%	78	88,64%
No	14	33,33%	10	11,36%

13. I got prepared and changed my driving behaviour after receiving the alert
Number of respondents: 175



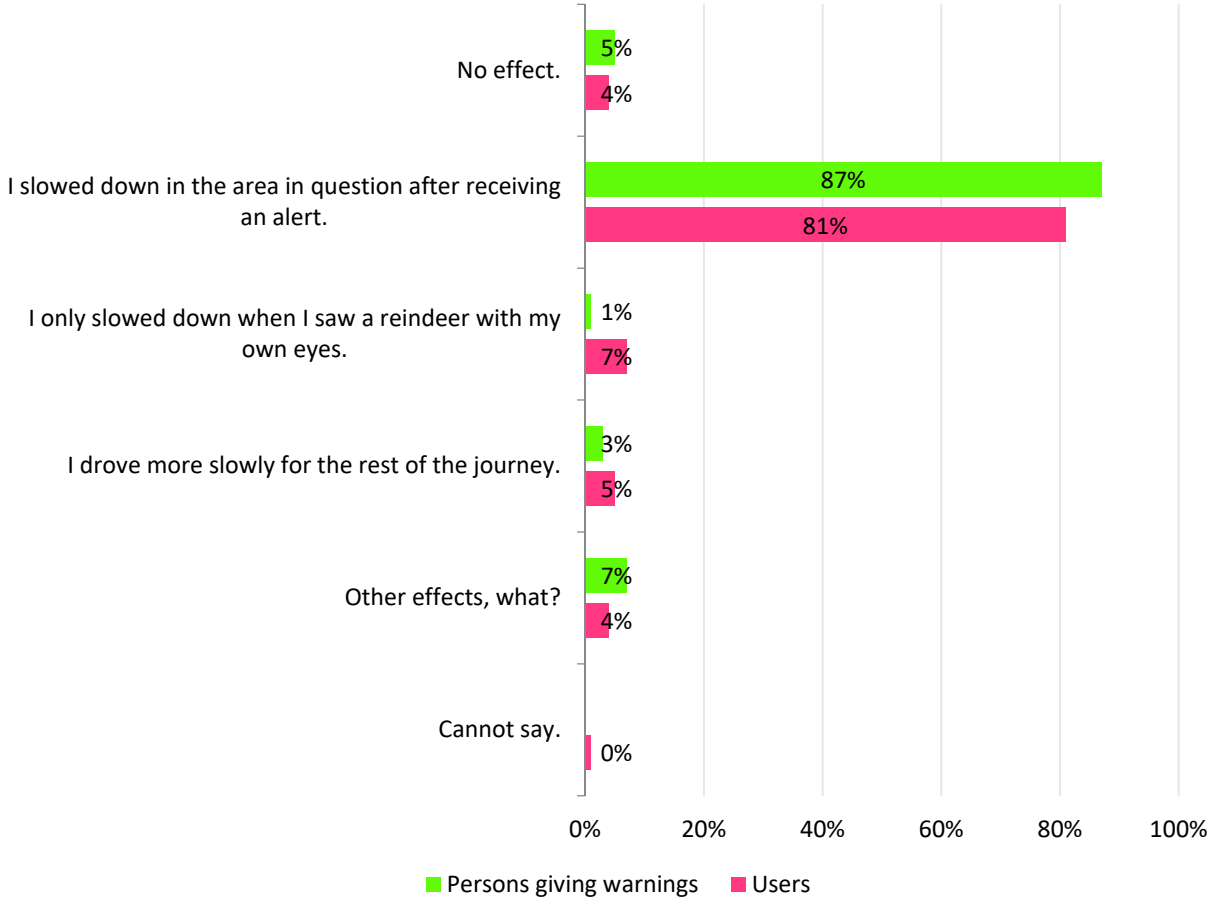
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	50	90,91%	106	88,33%
No	5	9,09%	14	11,67%

14. I avoided a collision because of the alert
Number of respondents: 150



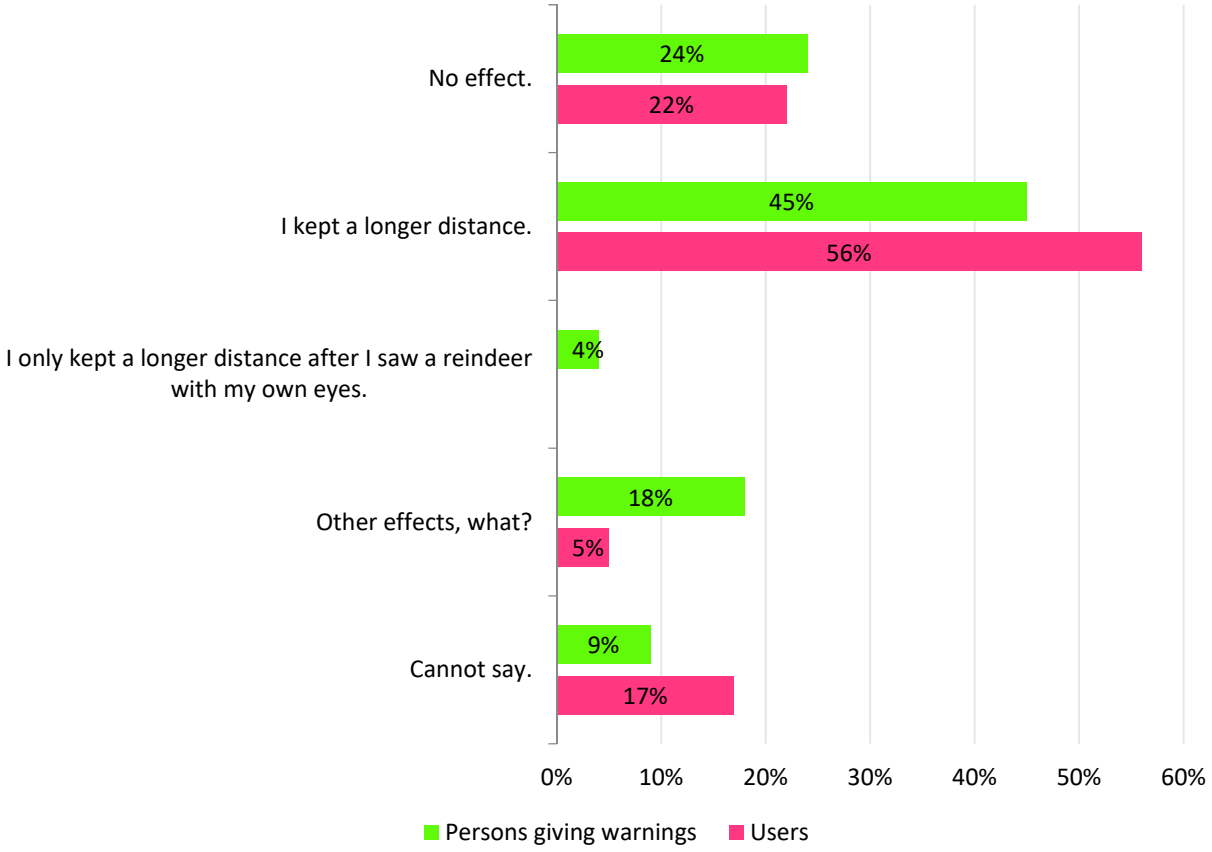
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes	14	29,17%	34	33,33%
No	34	70,83%	68	66,67%

15. DRIVING SPEED How did the alert affect your driving speed?
Number of respondents: 177, Number of chosen answers: 185



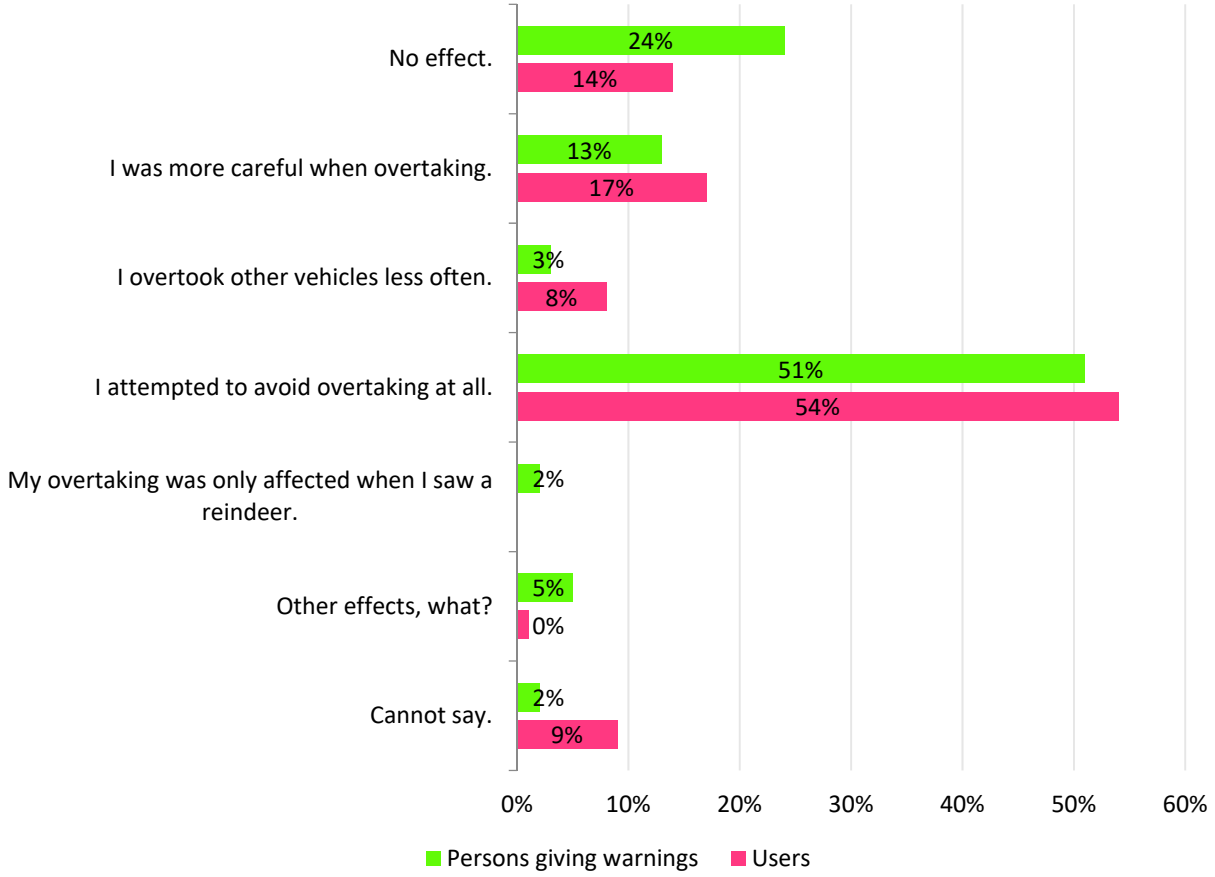
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
No effect.	3	5,45%	6	4,92%
I slowed down in the area in question after receiving an alert.	48	87,27%	99	81,15%
I only slowed down when I saw a reindeer with my own eyes.	1	1,82%	9	7,38%
I drove more slowly for the rest of the journey.	2	3,64%	7	5,74%
Other effects, what?	4	7,27%	5	4,1%
Cannot say.	0	0%	1	0,82%

16. DISTANCE TO THE VEHICLE AHEAD How did the alert affect to your distance to the vehicle ahead?
Number of respondents: 175



	Persons giving warnings		Users	
	n	Per cent	n	Per cent
No effect.	13	23,64%	27	22,5%
I kept a longer distance.	25	45,45%	67	55,83%
I only kept a longer distance after I saw a reindeer with my own eyes.	2	3,64%	0	0%
Other effects, what?	10	18,18%	6	5%
Cannot say.	5	9,09%	20	16,67%

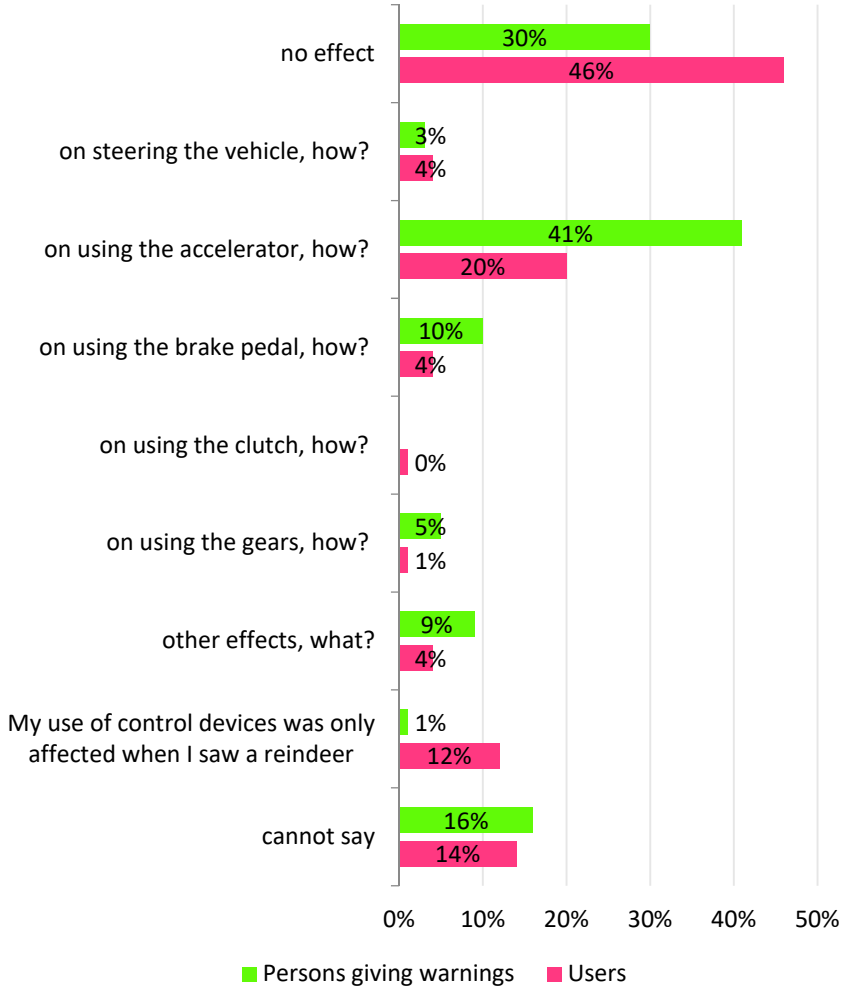
17. OVERTAKING How did the alert affect your overtaking behaviour? Number of respondents: 176, Number of chosen answers: 181



	Persons giving warnings		Users	
	n	Per cent	n	Per cent
No effect.	13	23,64%	17	14,05%
I was more careful when overtaking.	7	12,73%	21	17,36%
I overtook other vehicles less often.	2	3,64%	10	8,26%
I attempted to avoid overtaking at all.	28	50,91%	66	54,55%
My overtaking was only affected when I saw a reindeer.	1	1,82%	0	0%
Other effects, what?	3	5,45%	1	0,83%
Cannot say.	1	1,82%	11	9,09%

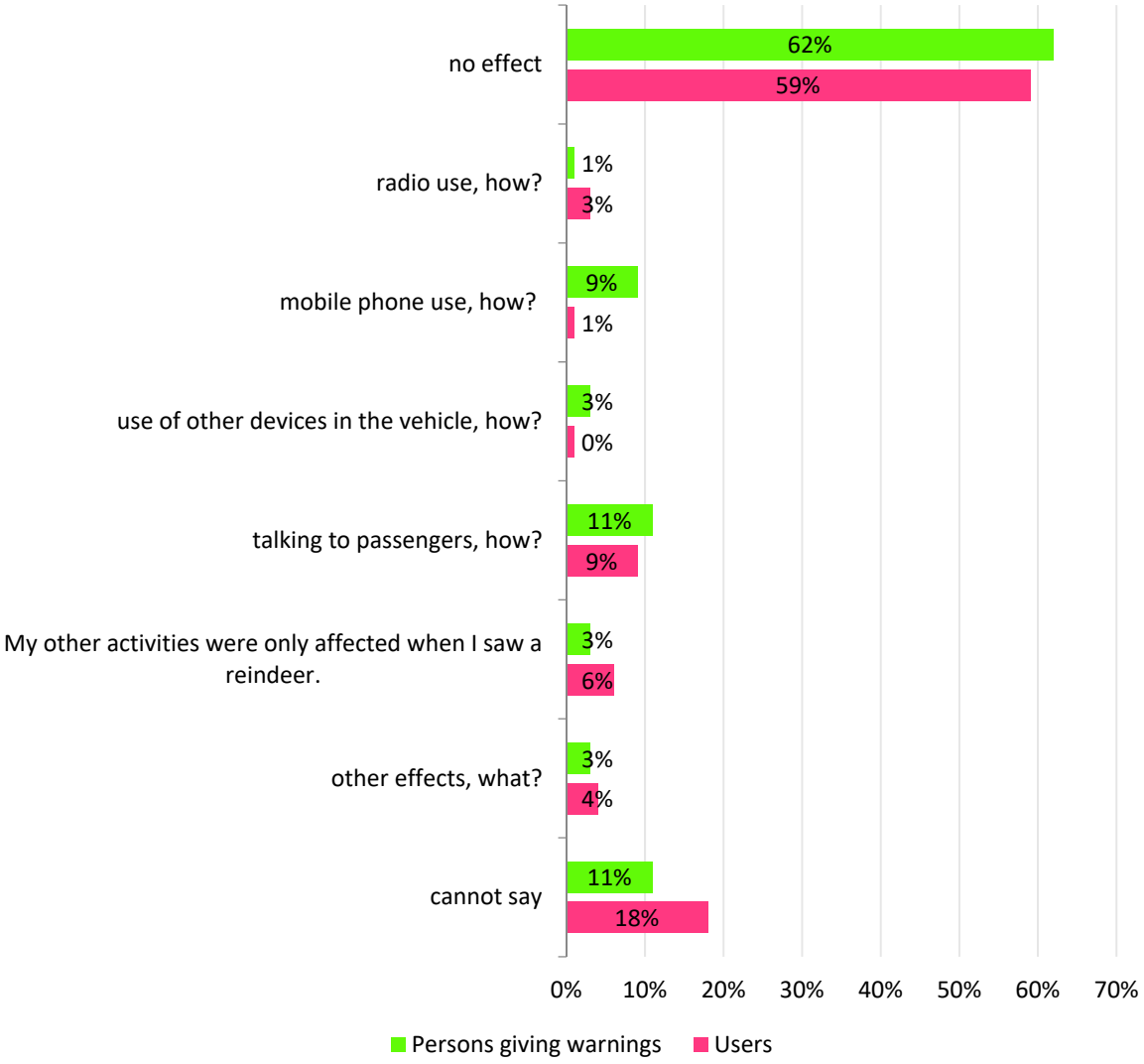
18. USE OF CONTROL DEVICES: How did the alert affect your use of control devices (steering wheel, pedals, gears, other control devices)?

Number of respondents: 176, Number of chosen answers: 200



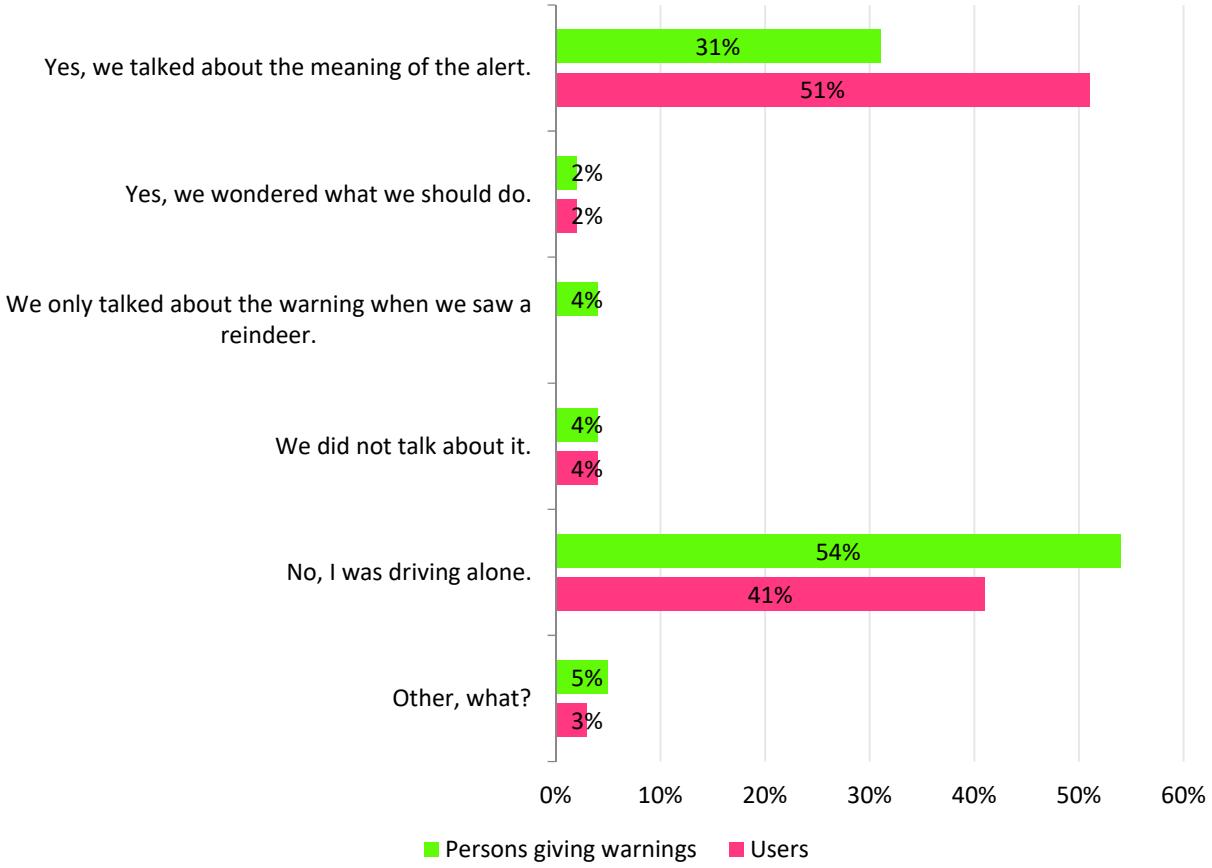
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
no effect	17	30,91%	56	46,28%
on steering the vehicle, how?	2	3,64%	6	4,96%
on using the accelerator, how?	23	41,82%	25	20,66%
on using the brake pedal, how?	6	10,91%	5	4,13%
on using the clutch, how?	0	0%	1	0,83%
on using the gears, how?	3	5,45%	2	1,65%
other effects, what?	5	9,09%	6	4,96%
My use of control devices was only affected when I saw a reindeer	1	1,82%	15	12,4%
cannot say	9	16,36%	18	14,88%

19. ACTIVITIES PERFORMED WHILE DRIVING How did the alert affect the activities performed while driving?
Number of respondents: 175, Number of chosen answers: 184



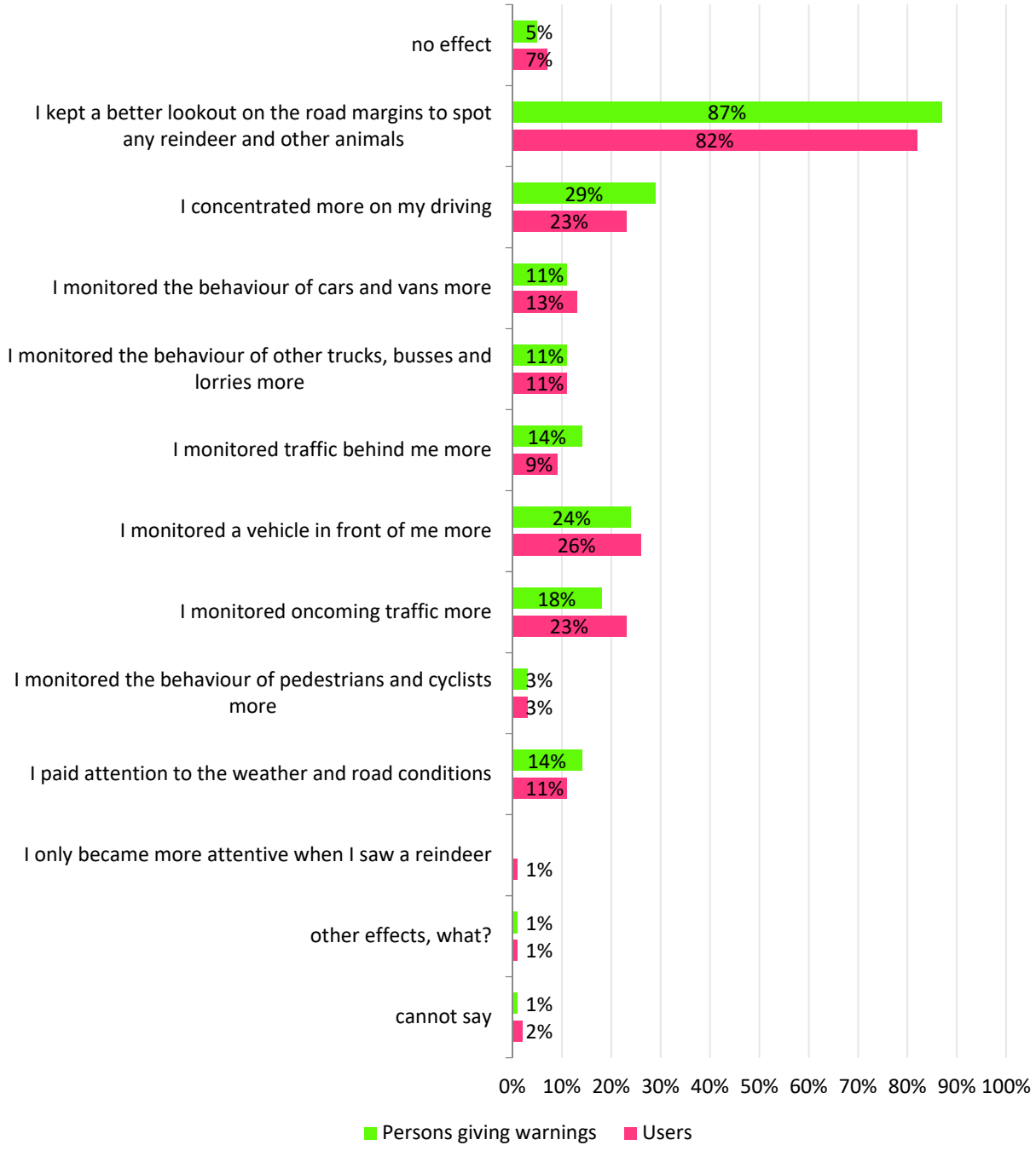
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
no effect	34	62,96%	72	59,5%
radio use, how?	1	1,85%	4	3,31%
mobile phone use, how?	5	9,26%	2	1,65%
use of other devices in the vehicle, how?	2	3,7%	1	0,83%
talking to passengers, how?	6	11,11%	11	9,09%
My other activities were only affected when I saw a reindeer.	2	3,7%	8	6,61%
other effects, what?	2	3,7%	6	4,96%
cannot say	6	11,11%	22	18,18%

20. DISCUSSING THE ALERT If you had a passenger, did you discuss the alert after receiving it?
Number of respondents: 176, Number of chosen answers: 179



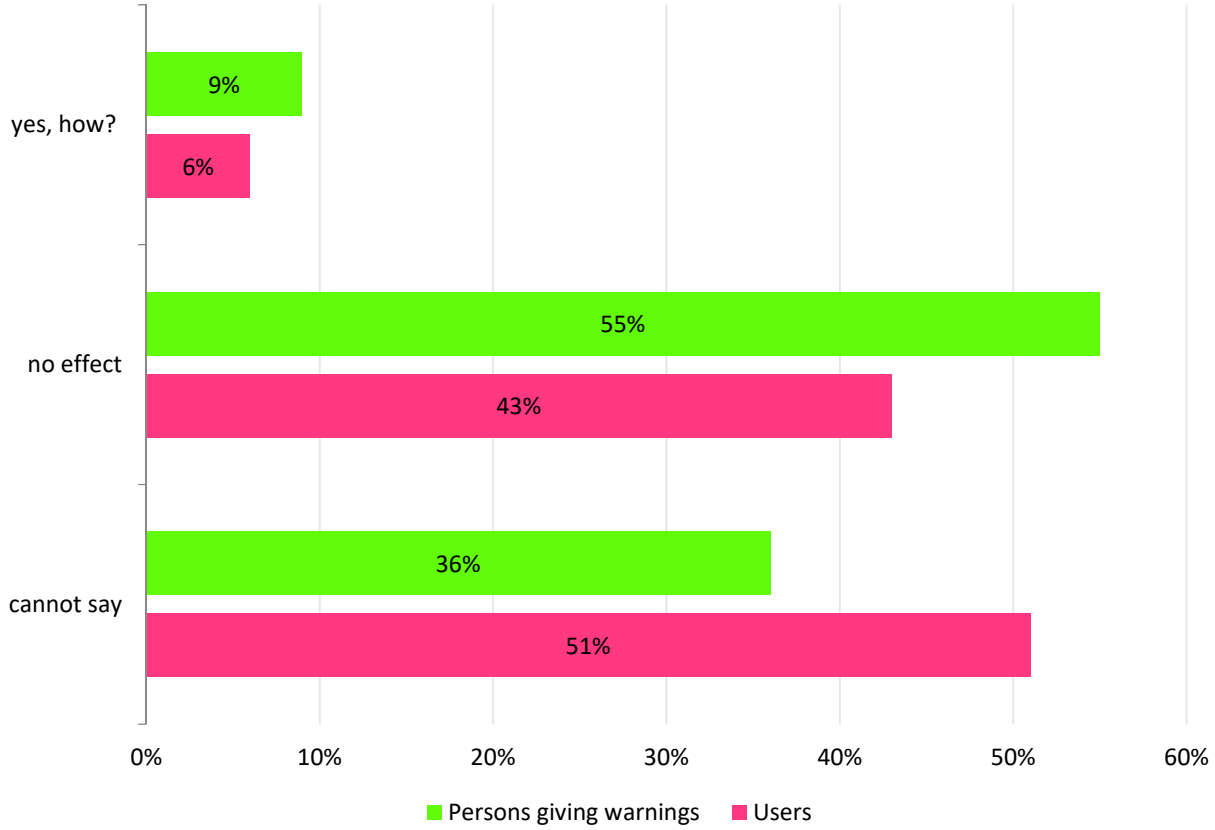
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
Yes, we talked about the meaning of the alert.	17	30,91%	62	51,24%
Yes, we wondered what we should do.	1	1,82%	3	2,48%
We only talked about the warning when we saw a reindeer.	2	3,64%	0	0%
We did not talk about it.	2	3,64%	5	4,13%
No, I was driving alone.	30	54,55%	50	41,32%
Other, what?	3	5,45%	4	3,31%

21. FOCUSING ATTENTION How did the alert affect the way you focused your attention (what kind of information did you seek for in the traffic environment)?
Number of respondents: 175, Number of chosen answers: 386



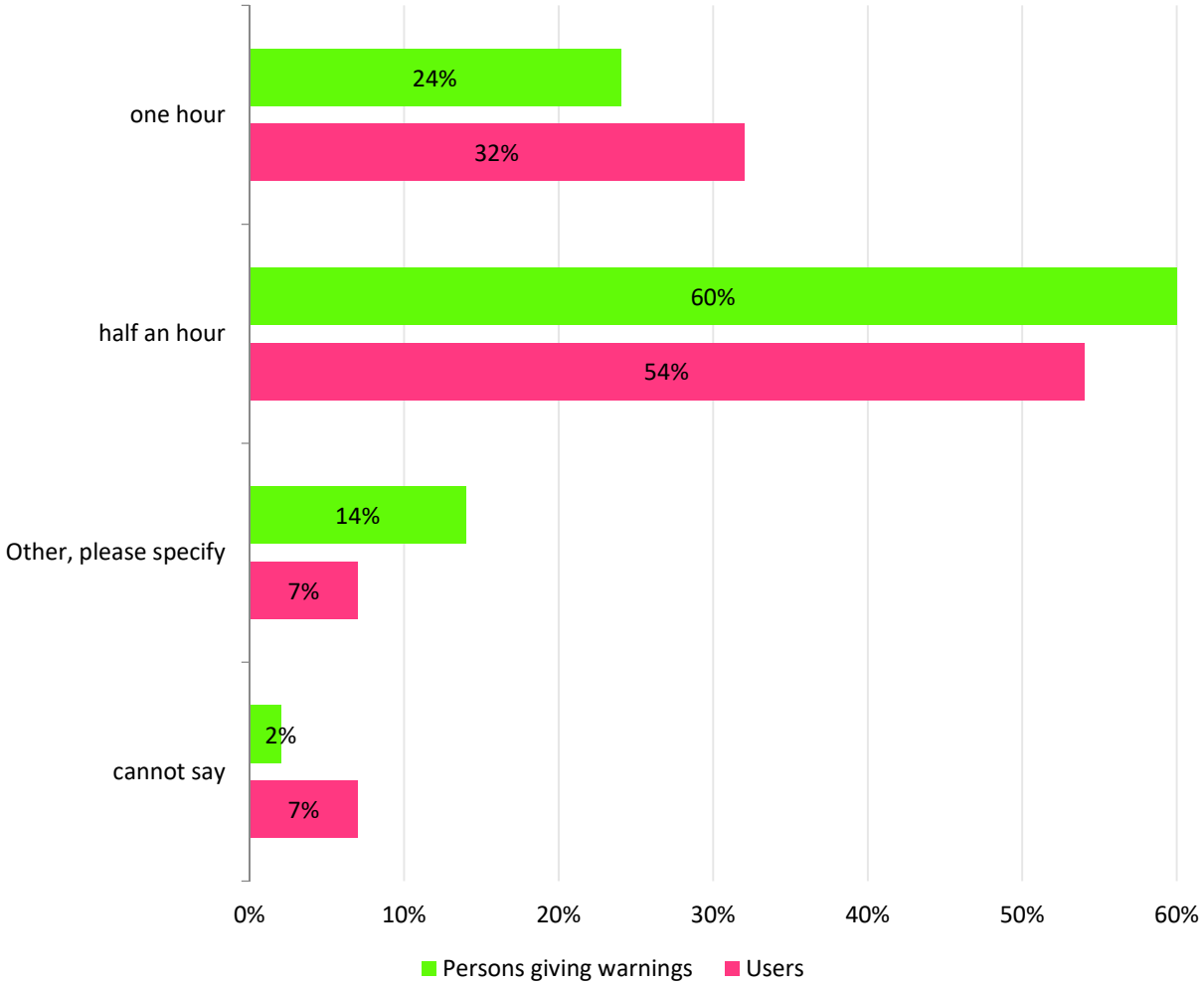
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
no effect	3	5,56%	9	7,44%
I kept a better lookout on the road margins to spot any reindeer and other animals	47	87,04%	100	82,64%
I concentrated more on my driving	16	29,63%	28	23,14%
I monitored the behaviour of cars and vans more	6	11,11%	16	13,22%
I monitored the behaviour of other trucks, busses and lorries more	6	11,11%	14	11,57%
I monitored traffic behind me more	8	14,81%	12	9,92%
I monitored a vehicle in front of me more	13	24,07%	32	26,45%
I monitored oncoming traffic more	10	18,52%	29	23,97%
I monitored the behaviour of pedestrians and cyclists more	2	3,7%	4	3,31%
I paid attention to the weather and road conditions	8	14,81%	14	11,57%
I only became more attentive when I saw a reindeer	0	0%	2	1,65%
other effects, what?	1	1,85%	2	1,65%
cannot say	1	1,85%	3	2,48%

22. OTHER IMPACTS Did receiving the alert have any other impacts?
Number of respondents: 167



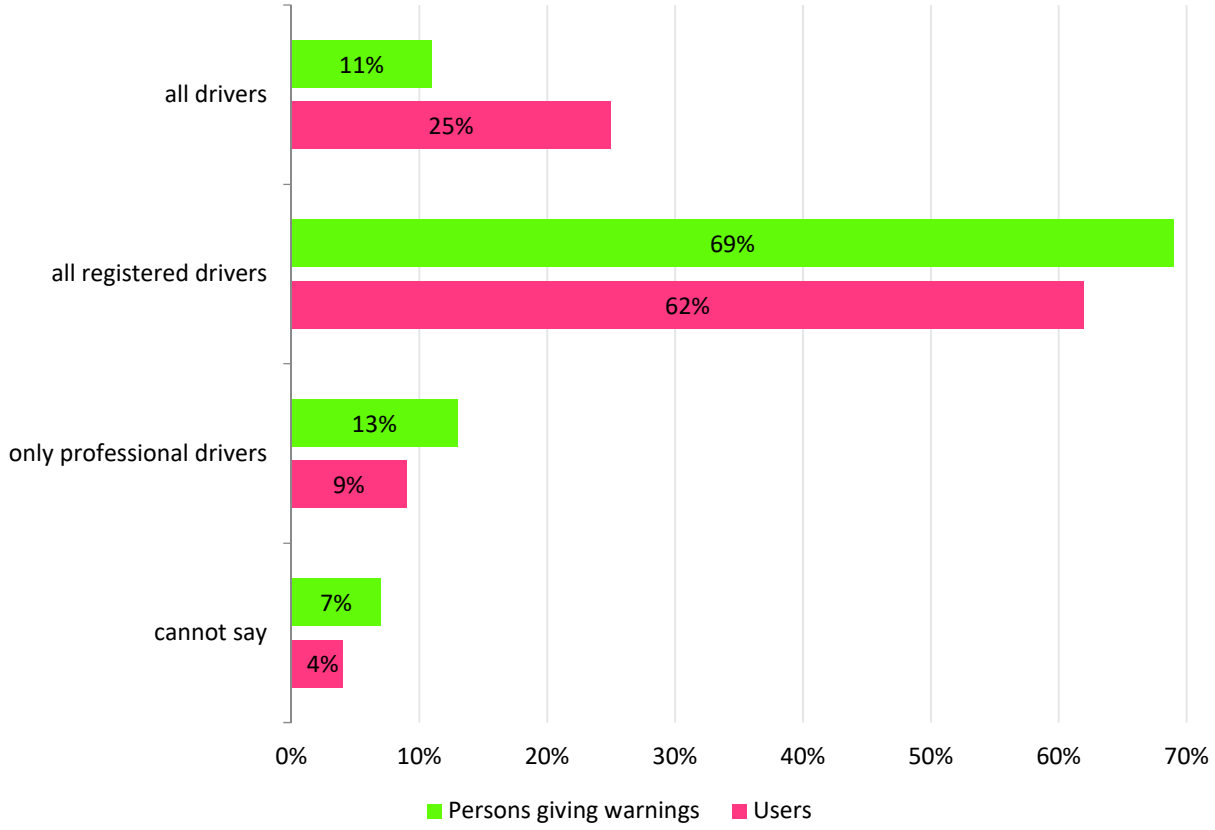
	Persons giving warnings		Users	
	n	Per cent	n	Per cent
yes, how?	5	9,09%	7	6,25%
no effect	30	54,55%	48	42,86%
cannot say	20	36,36%	57	50,89%

23. A Porokello alert is currently valid for half an hour. Until June 2018, the validity period was one hour. How long should a Porokello alert be valid?
Number of respondents: 179



	Persons giving warnings		Users	
	n	Per cent	n	Per cent
one hour	13	23,64%	39	31,45%
half an hour	33	60%	67	54,03%
Other, please specify	8	14,54%	9	7,26%
cannot say	1	1,82%	9	7,26%

24. Who should be able to give Porokello warnings?
Number of respondents: 180



	Persons giving warnings		Users	
	n	Per cent	n	Per cent
all drivers	6	10,91%	32	25,6%
all registered drivers	38	69,09%	77	61,6%
only professional drivers	7	12,73%	11	8,8%
cannot say	4	7,27%	5	4%