Water and forest road networks in Quebec: issues and solutions

ASCF Webinar

February 3, 2021

Sylvain Jutras, ing.f., Ph.D.
Full professor, forest hydrology specialist
Département des sciences du bois et de la forêt

Karelle Gilbert, Ph.D. student

UNIVERSITÉ LAVAL

Faculté de foresterie, de géographie et de géomatique

cef
Centre d'étude de la forêt

CentrEau
Centre de recherche sur l'eau
Water Research Centre

CAPSA

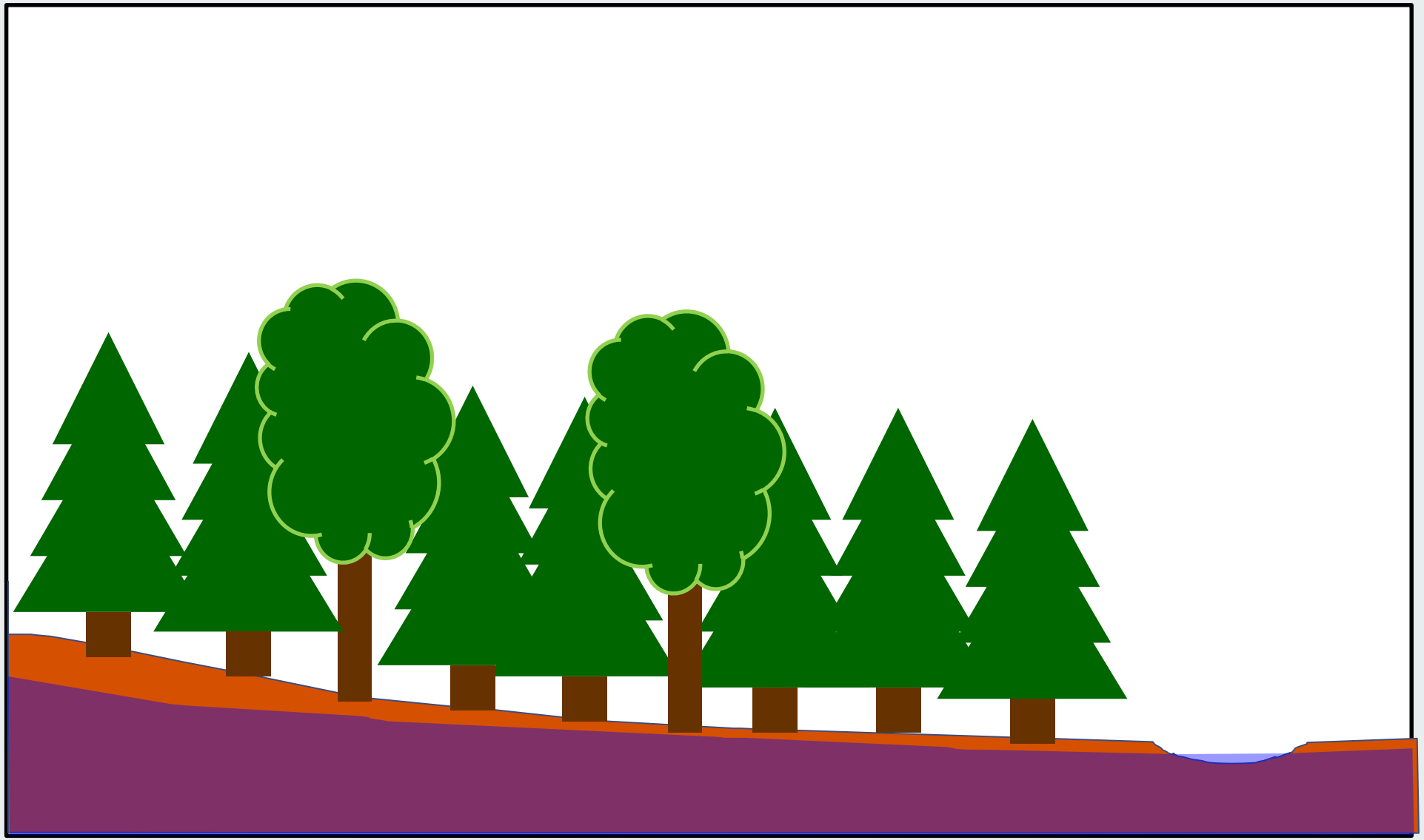
Water issues in forest environment

Main threat :

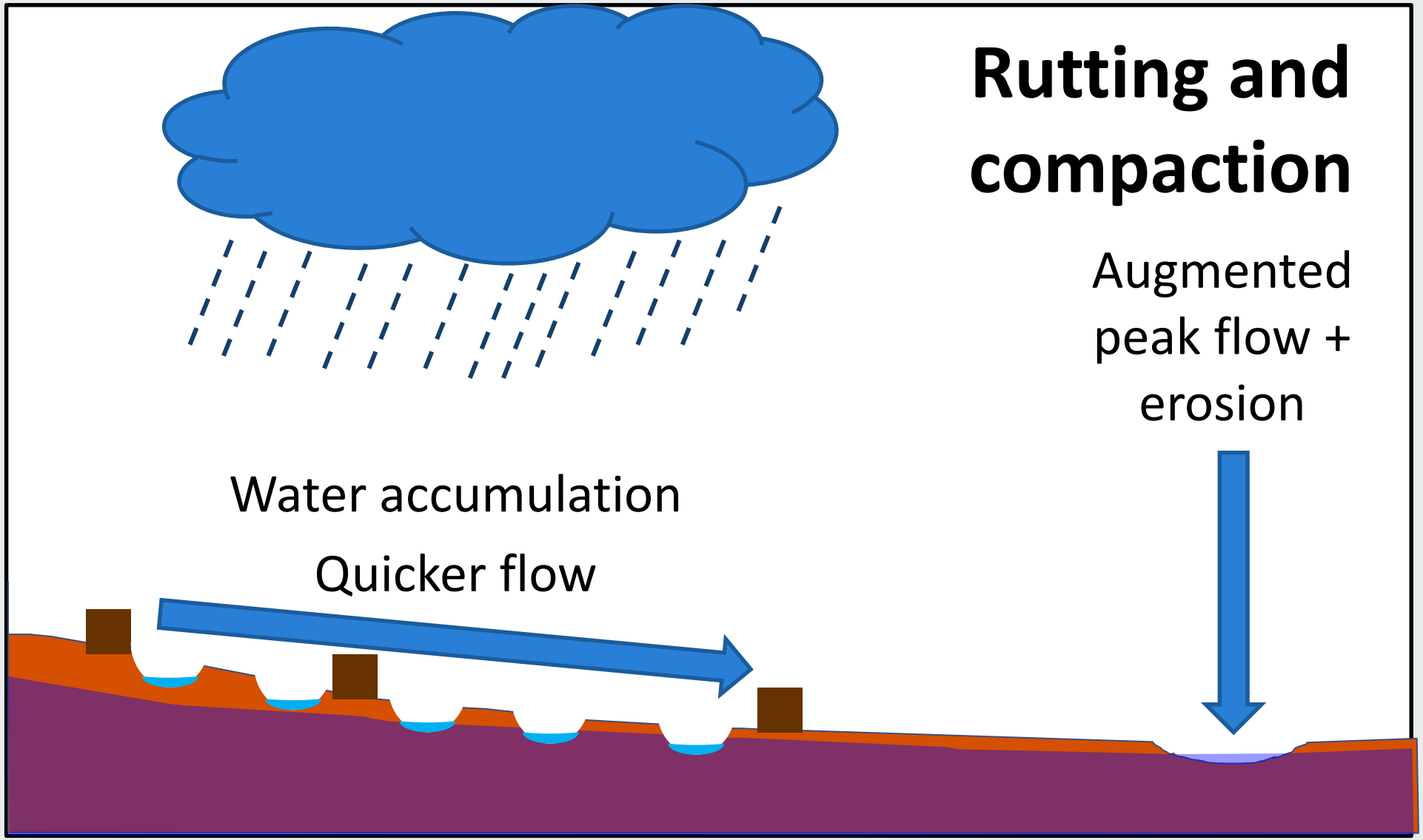
External sediment input to streams

- From forest harvesting
  - Erosion from damaged soils
    - Solution : Limit rutting
  - Sediment input to streams
    - Solution : Riparian buffers

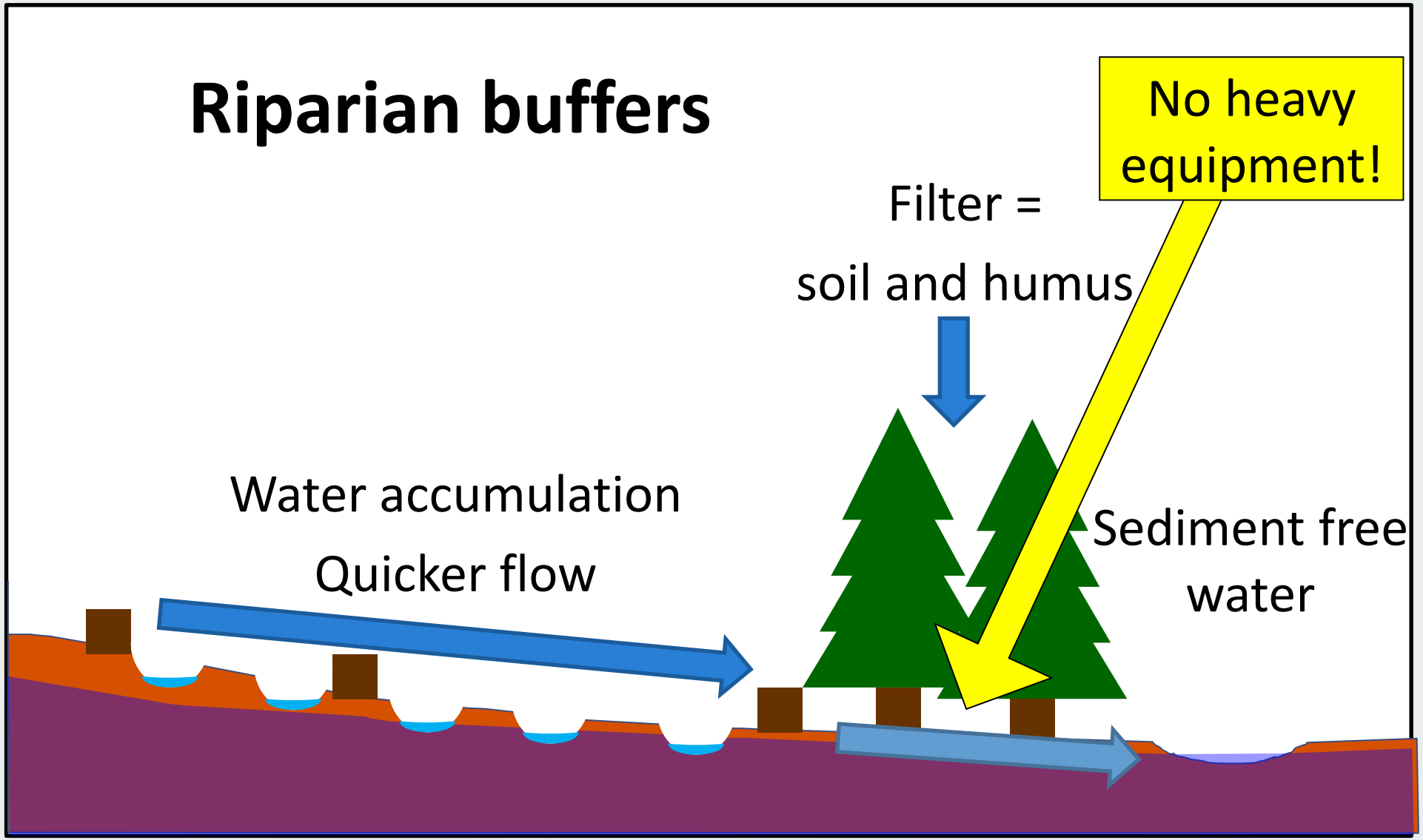
Forest harvesting and water



Forest harvesting and water



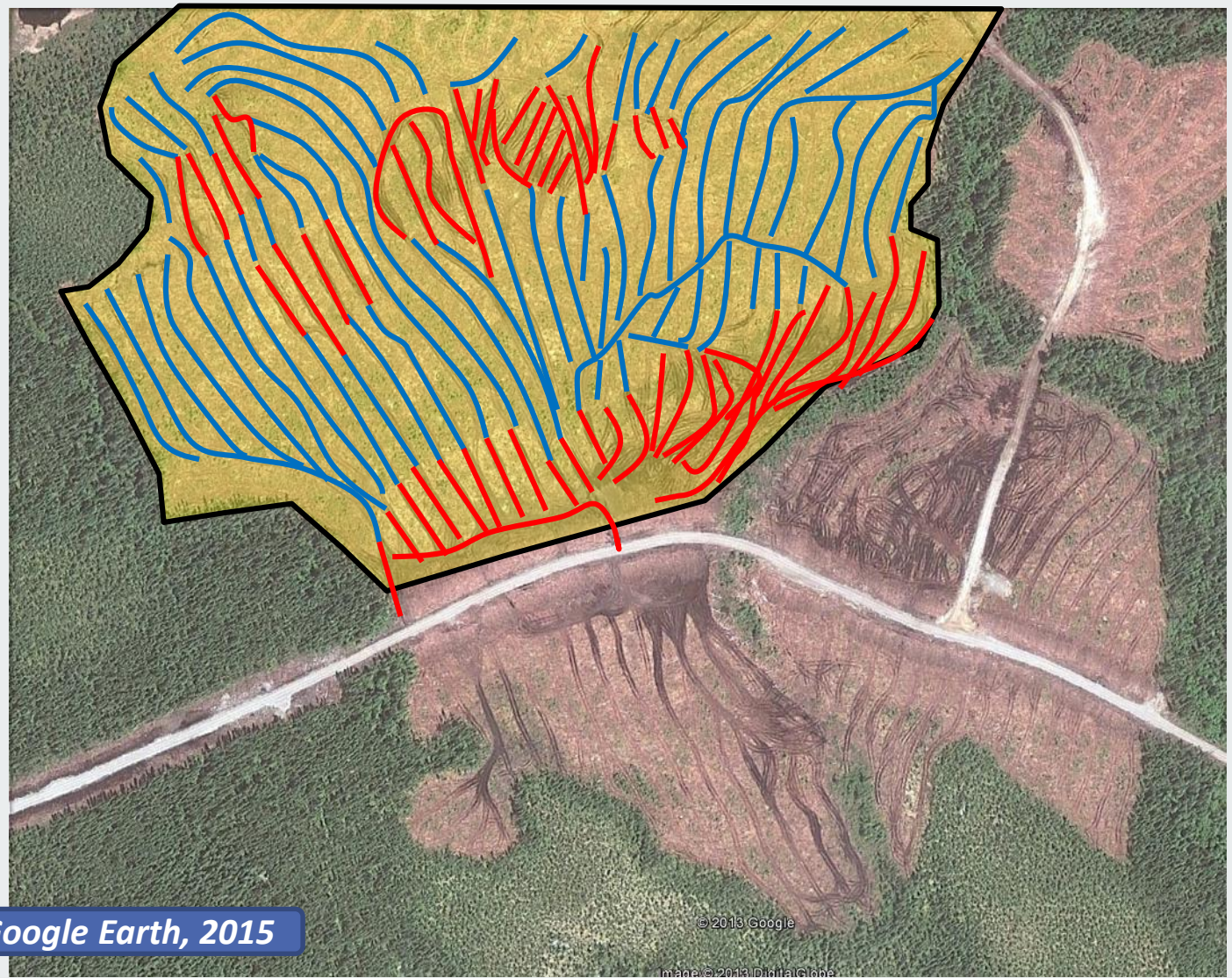
Forest harvesting and water



Sound practices: Soil and Water

- Limit rutting
  - Quebec's regulation
    - RADF; Art. 45

Ruts < 25 % of total trail length for each wood cutting area

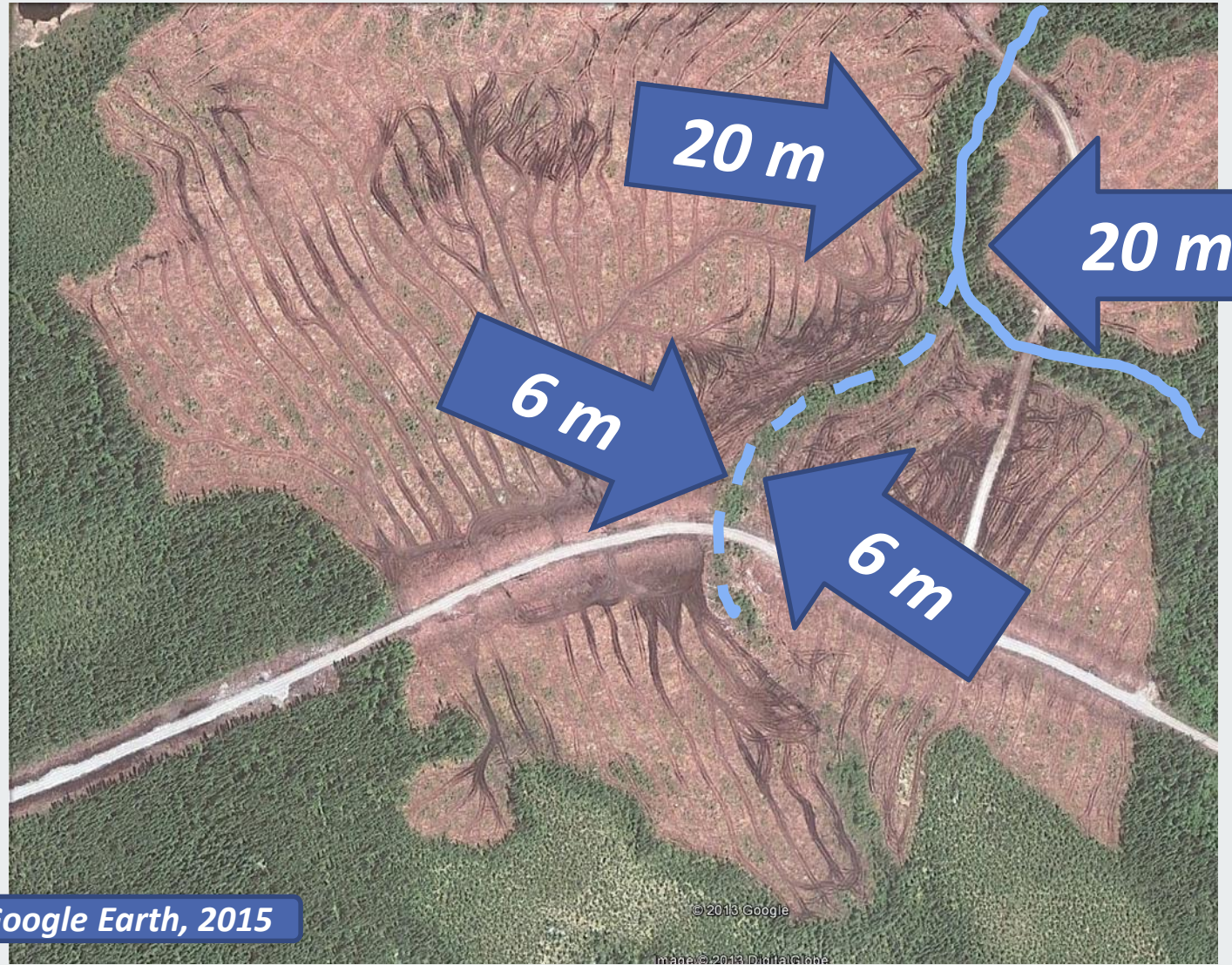


Google Earth, 2015

Sound practices: Riparian buffer

- Wooded strips protection
  - Quebec's regulation
    - RADF; numerous articles
  - No heavy equipment
  - Harvesting
    - Sometimes allowed
    - Sometimes forbidden

Permanent = 20 m
Intermittent = 6 m



Google Earth, 2015

Water issues in forest environment

Main threat :

External sediment input to streams

- From forest road networks
  - Water crossings are contact points
    - Solution : Proper construction
  - Forest roads can be aggravating factors
    - Solution : Proper maintenance

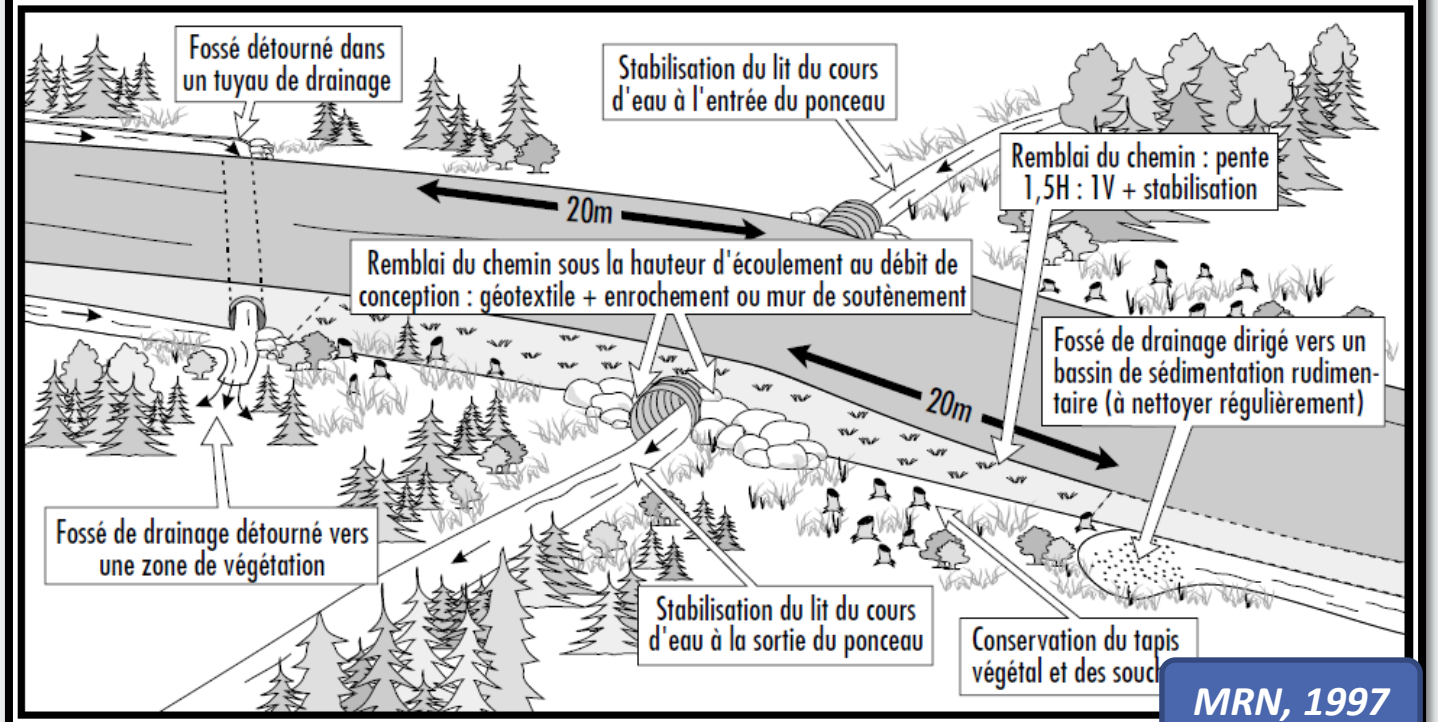
Forest road networks management in Quebec

- Forest road construction on **public land**
  - RNI (1988 - 2018)
  - RADF (since 2018)

- Maintenance
  - Frequent use
    - RADF, Art. 97
  - Roads without users
    - No law or regulation
    - No plan, no follow-up

Figure 28

Quelques normes à respecter lors de l'aménagement d'un ponceau



MRN, 1997

Threat to aquatic habitat

Frequent use
= Maintenance

Paradis-Lacombe 2016

Threat to aquatic habitat

No users
= No follow-up

Karelle Gilbert 2015

Threat to aquatic habitat

If frequent use
= Maintenance

If no users
= No follow-up

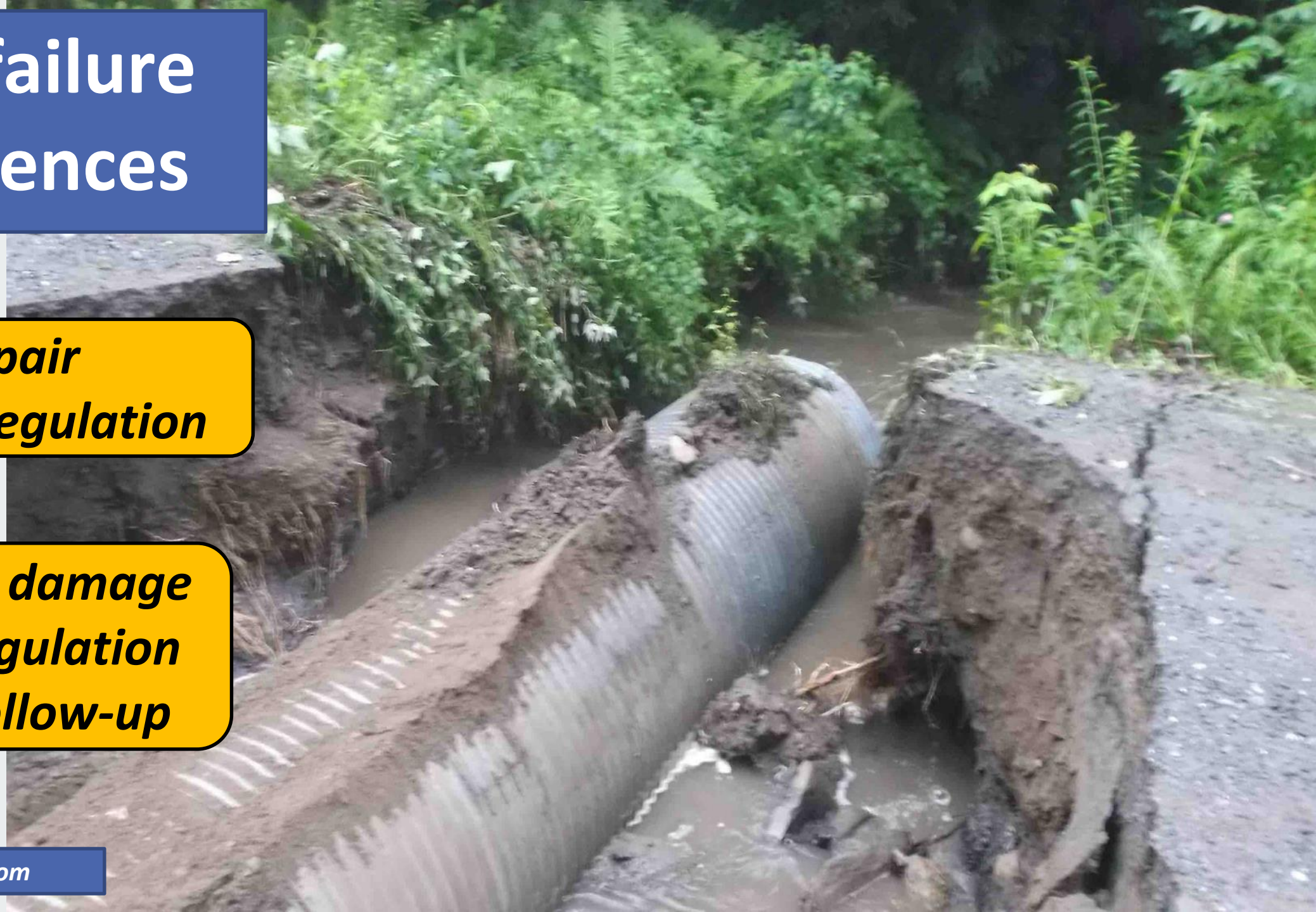
Paradis-Lacombe 2016

Threat to aquatic habitat

Barrier to fish passage

Paradis-Lacombe 2016

Culvert failure consequences



Repair
= Strict regulation

Existing damage
= No regulation
= No follow-up

Culvert failure consequences

Repair
= Strict regulation

Martin Seto 2005

Culvert failure consequences

Existing damage
= No regulation
= No follow-up

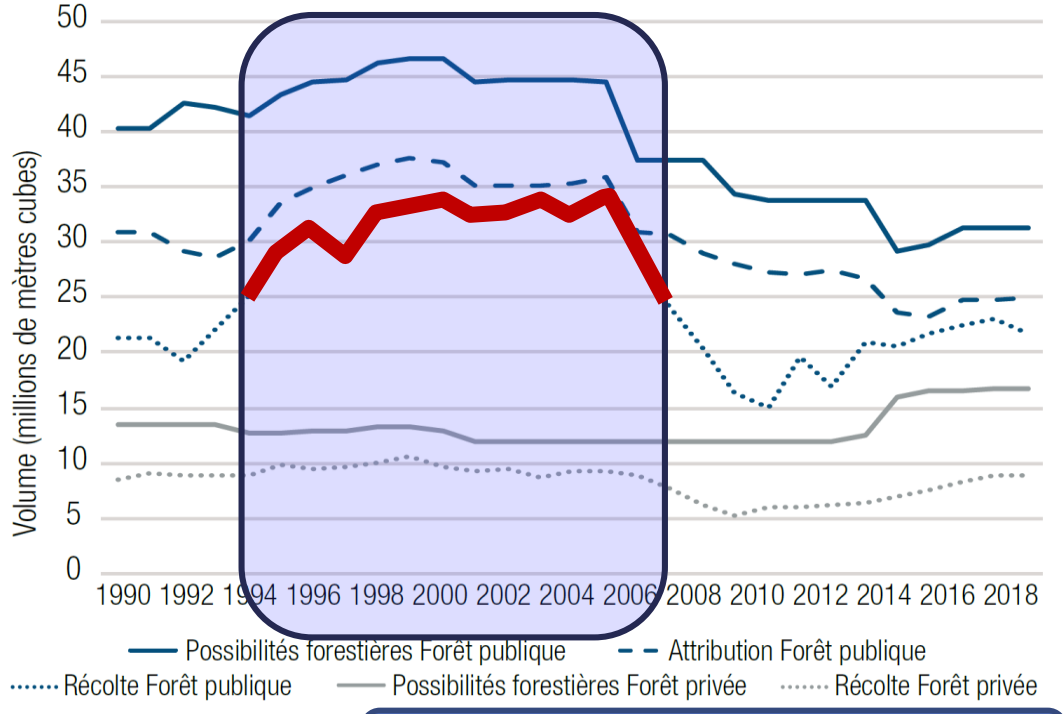
Martin Seto 2005

Forest road networks management in Quebec

- Forest roads in public forests :
  - Road network mainly built for forest harvesting
    - Gradually : 1960 – 1980
    - Intensively : 1990 – 2010
      - Strict application of the regulation (RNI)
  - Multipurpose use of roads
    - Wildlife, forest education, research, etc.

- What is the current state of forest road networks in Quebec?

Figure 3 : Évolution du volume de récolte par rapport aux possibilités forestières en forêts publique et privée depuis 1990[4]



Stratégie nationale de production de bois (Gouv. QC 2020)

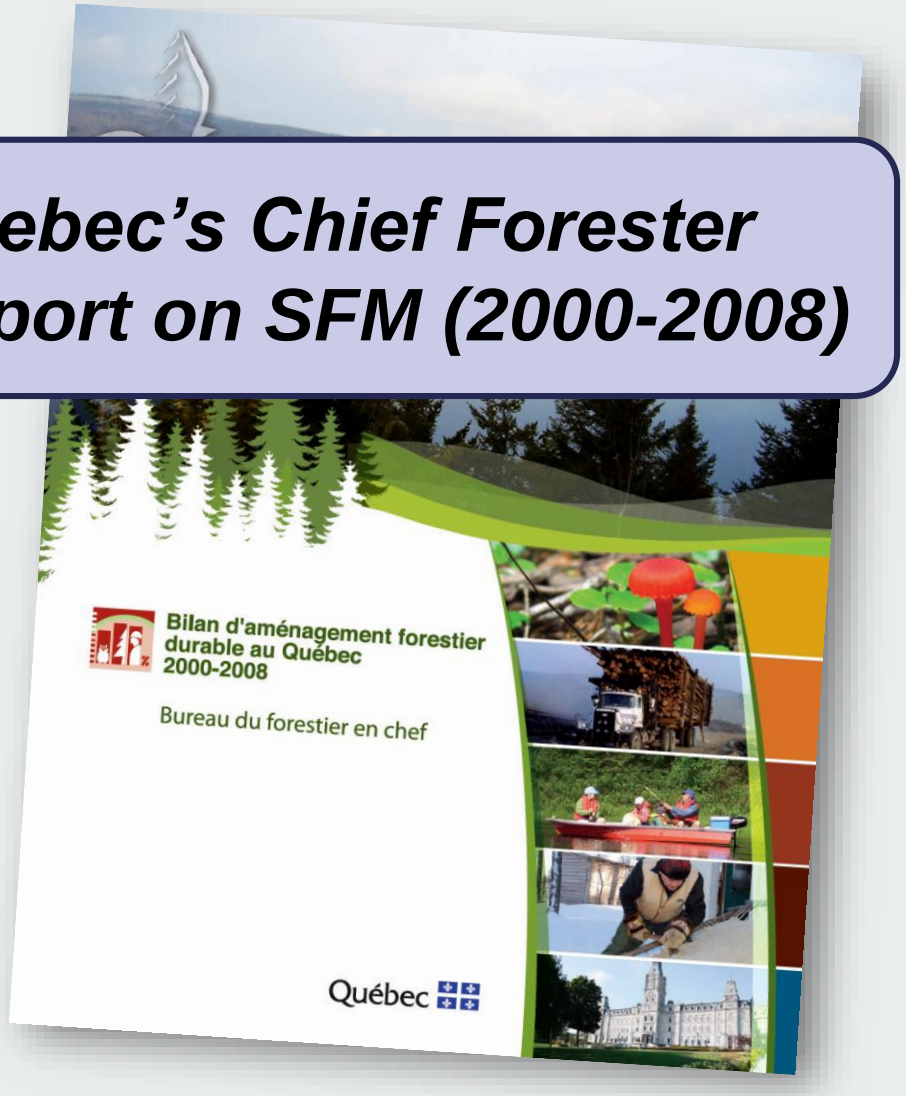
State of forest road networks (BFC 2010)

Des vieux chemins sans surveillance

Les entreprises forestières sont responsables de l'état des chemins pendant leur utilisation. Après cette période, les entreprises n'effectuent aucun suivi de ces chemins.

Les entrevues réalisées par le Bureau du forestier en chef ont permis de constater qu'il y a absence de suivi, de bilan ou de plan d'action à l'égard des vieux chemins[20] et des vieux ouvrages permettant de traverser les cours d'eau[21]. En outre, il n'existe aucune évaluation de l'ampleur du réseau routier forestier abandonné et de son apport de sédiments dans le milieu aquatique. Il n'y a pas non plus de suivi des vieux ouvrages pour traverser les cours d'eau permettant de vérifier les cas d'érosion, d'affouillement[22] et de modification de la vitesse de l'eau. La vitesse de l'eau peut constituer une limite au passage des poissons.

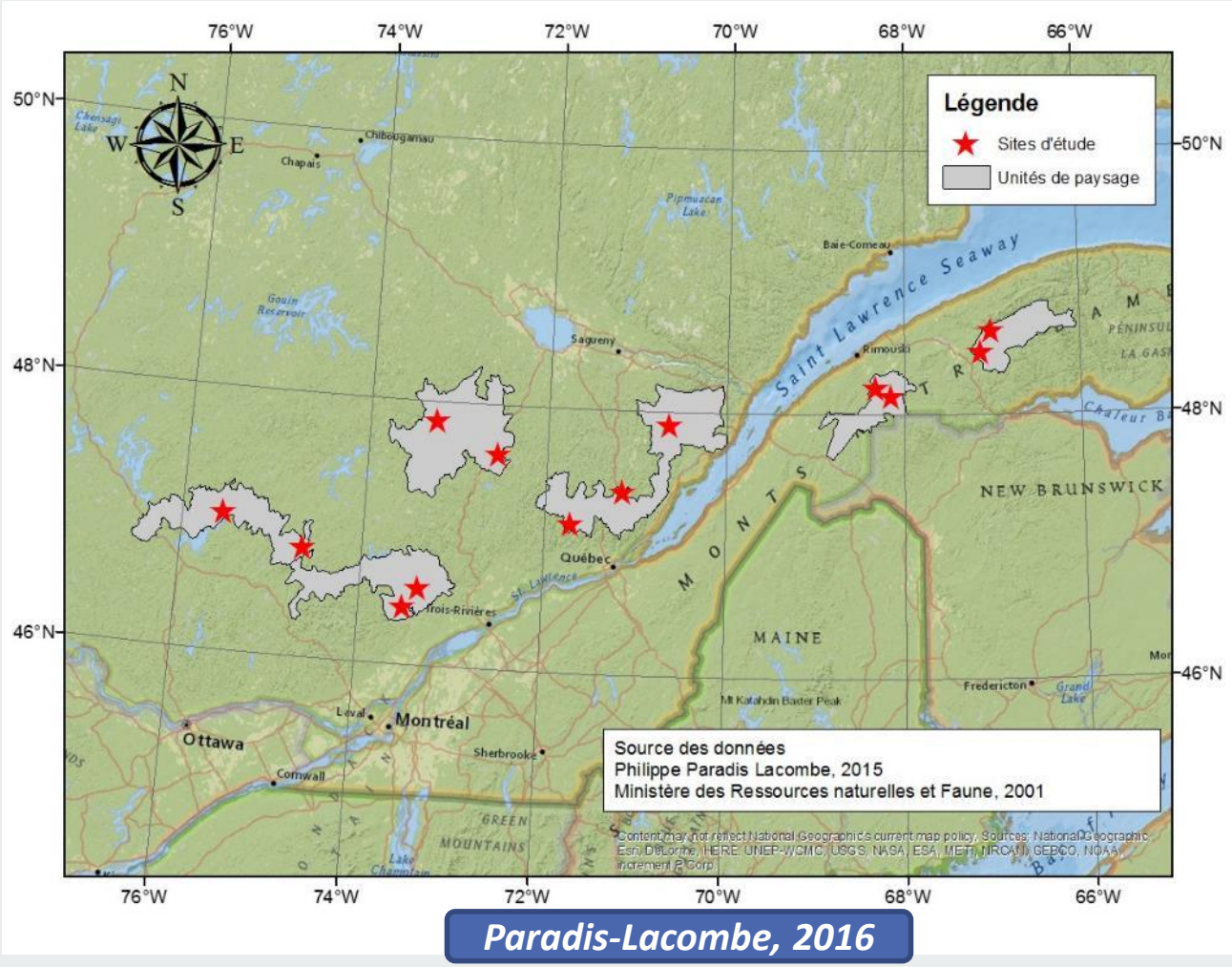
Quebec's Chief Forester Report on SFM (2000-2008)



State and durability of water crossings

Paradis-Lacombe et Jutras 2016

- Wildlife Foundation project
  - Outfitters + Wildlife managers
- 13 watersheds
  - 12 - 20 km²
  - 6 landscape units
- Exhaustive inventory
  - Roads
  - Water crossings

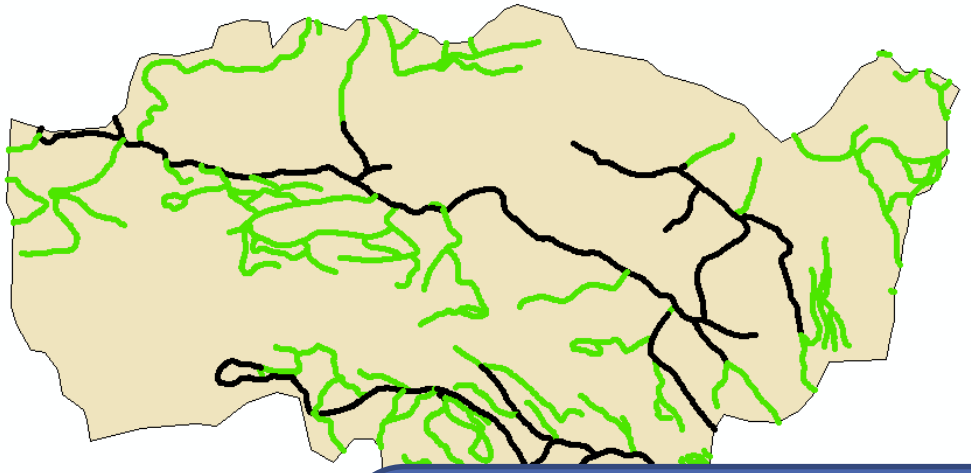


Paradis-Lacombe, 2016

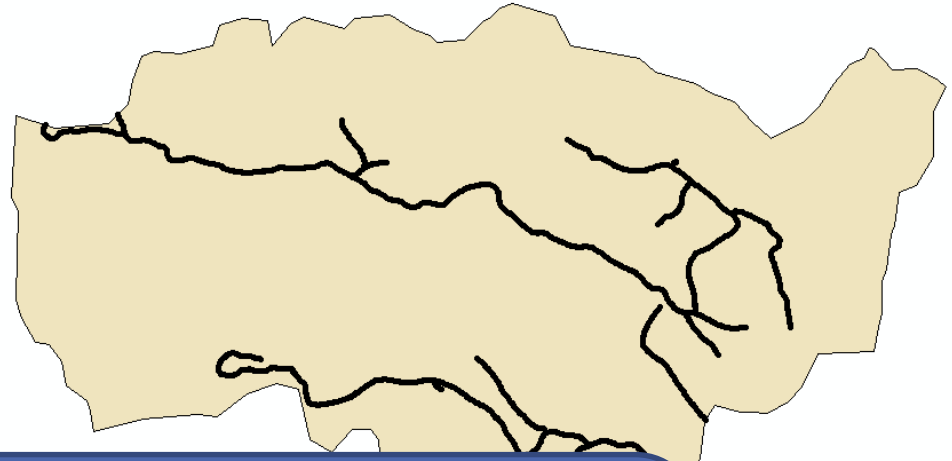
Results : State of provincial databases

- Comparison of governmental forest roads databases

3rd National inventory (1991-2003)



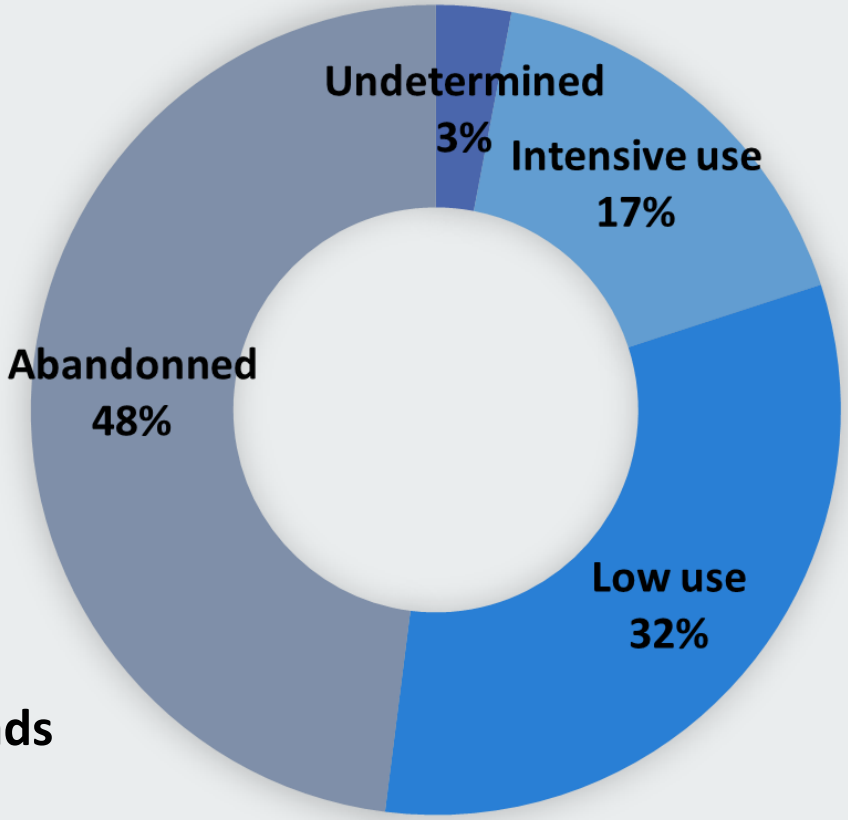
4th National inventory (2001-2017)



4th Nat. Inv. = 330 000 km of roads (Morvan 2012)
+ 4 % new roads
+ 18 % erased from previous database
+ 13 % never digitized

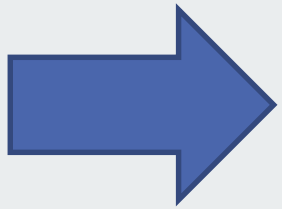
Results : State of forest roads

- > 525 km of roads studied
  - 3 months of intensive field work in the Summer of 2015
- Extrapolation of results to all 6 landscape units (36 000 km²)



Studied roads

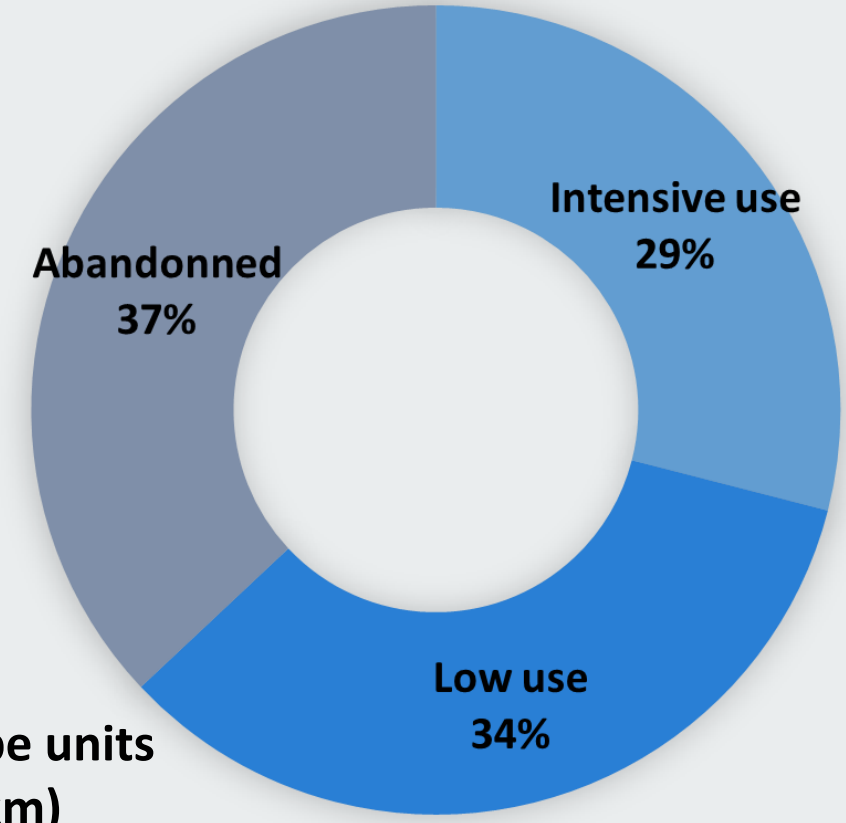
(527 km)



Total

Landscape units

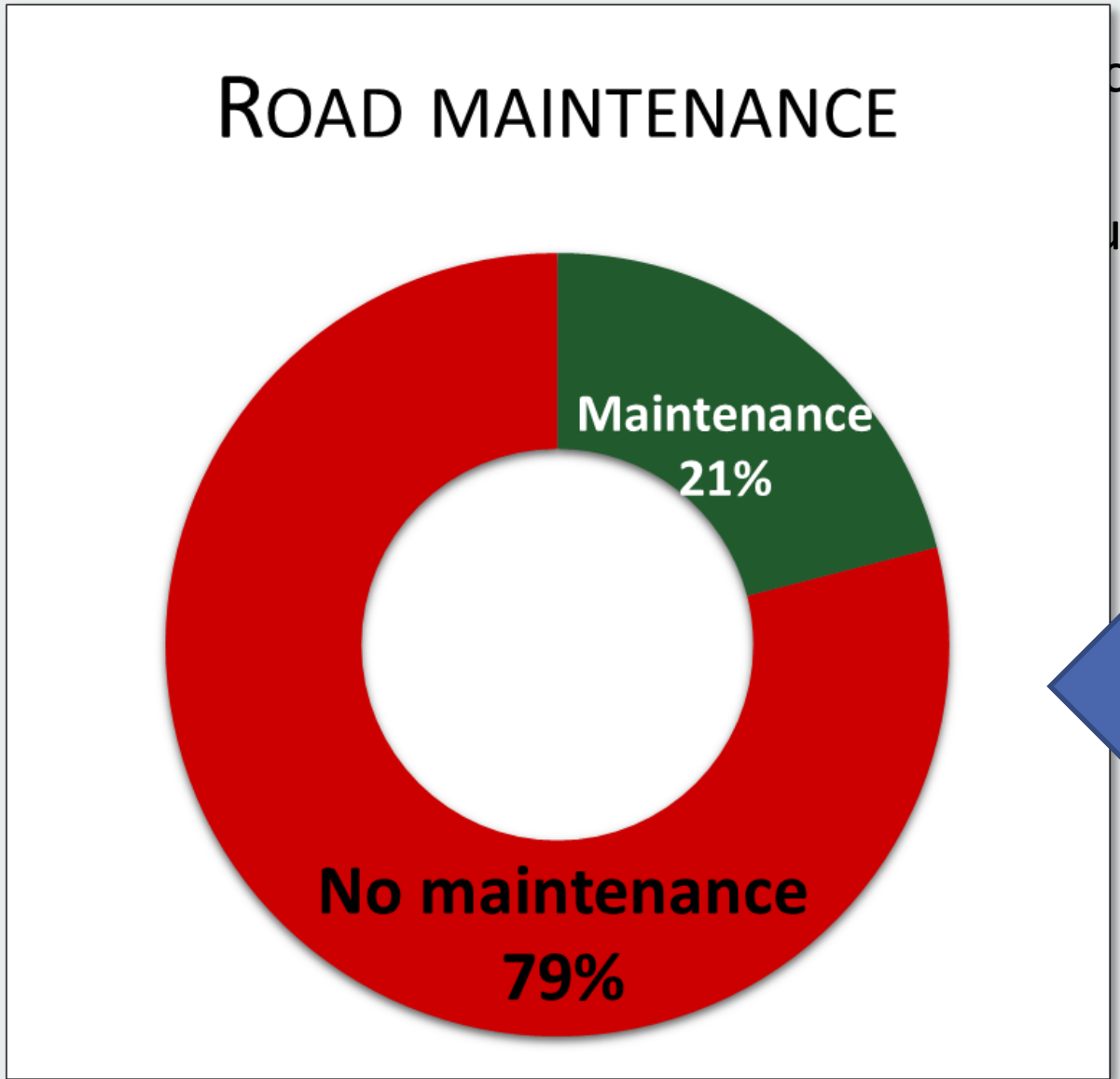
(36 000 km)

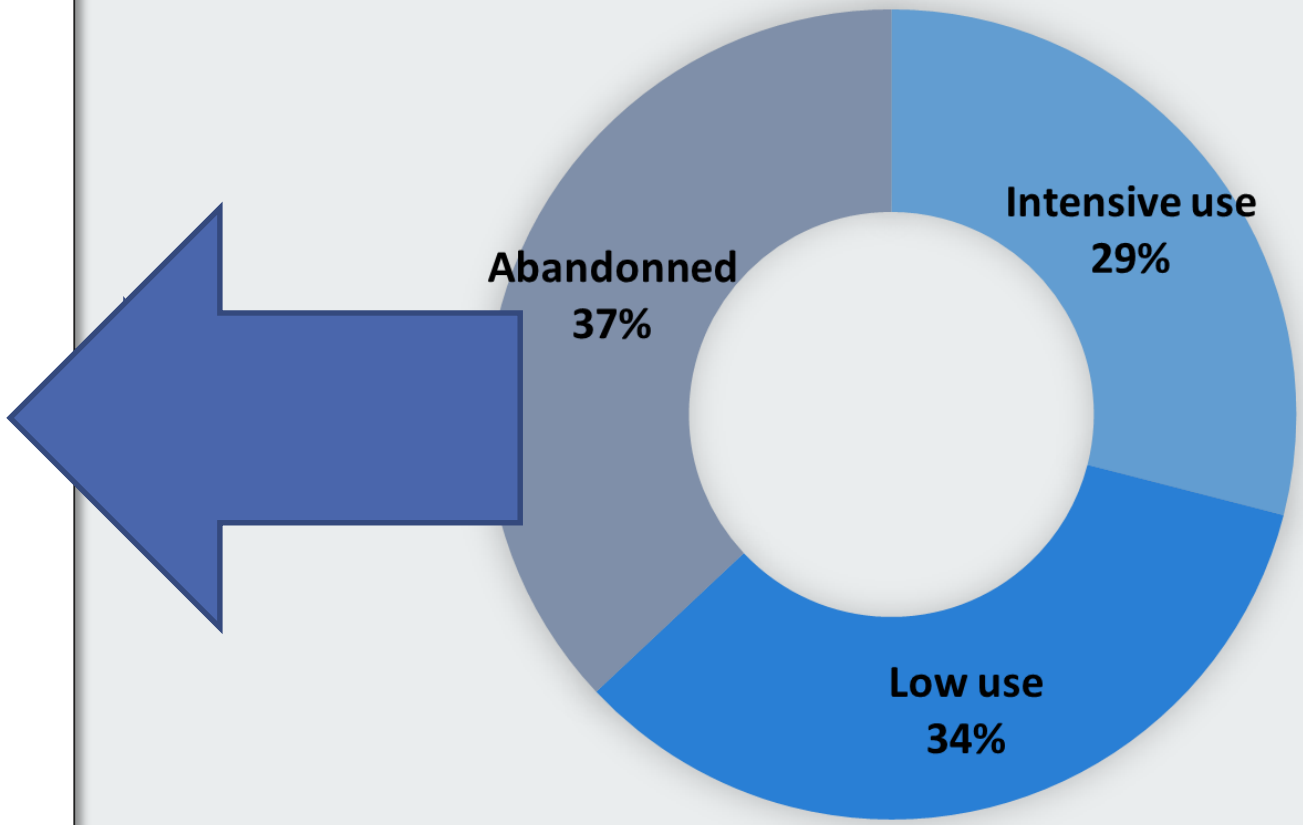


Results : State of forest roads

cule ou à pied

unités de paysages (25 000 km²)



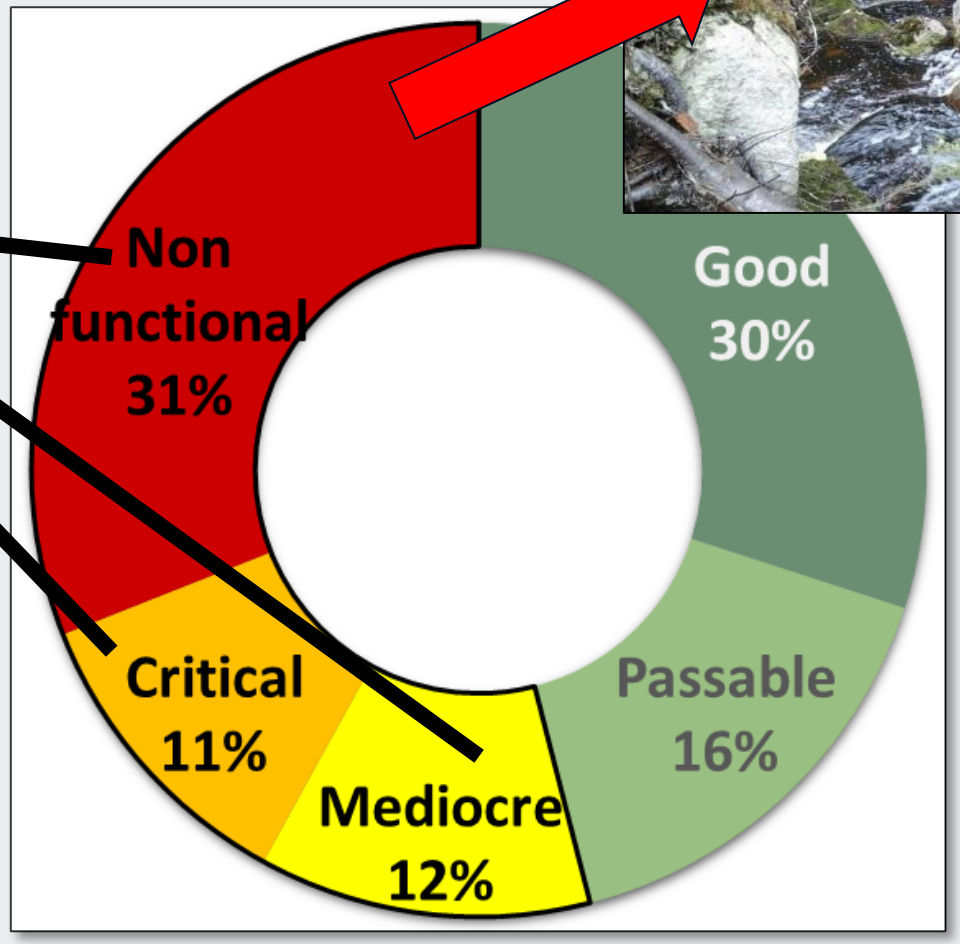


Results : State of water crossings

- 374 water crossings studied
  - Extrapolation of results to all 6 landscape units (34 000)

54 % seriously deteriorated

Maximum service life of metal culverts < 30 years



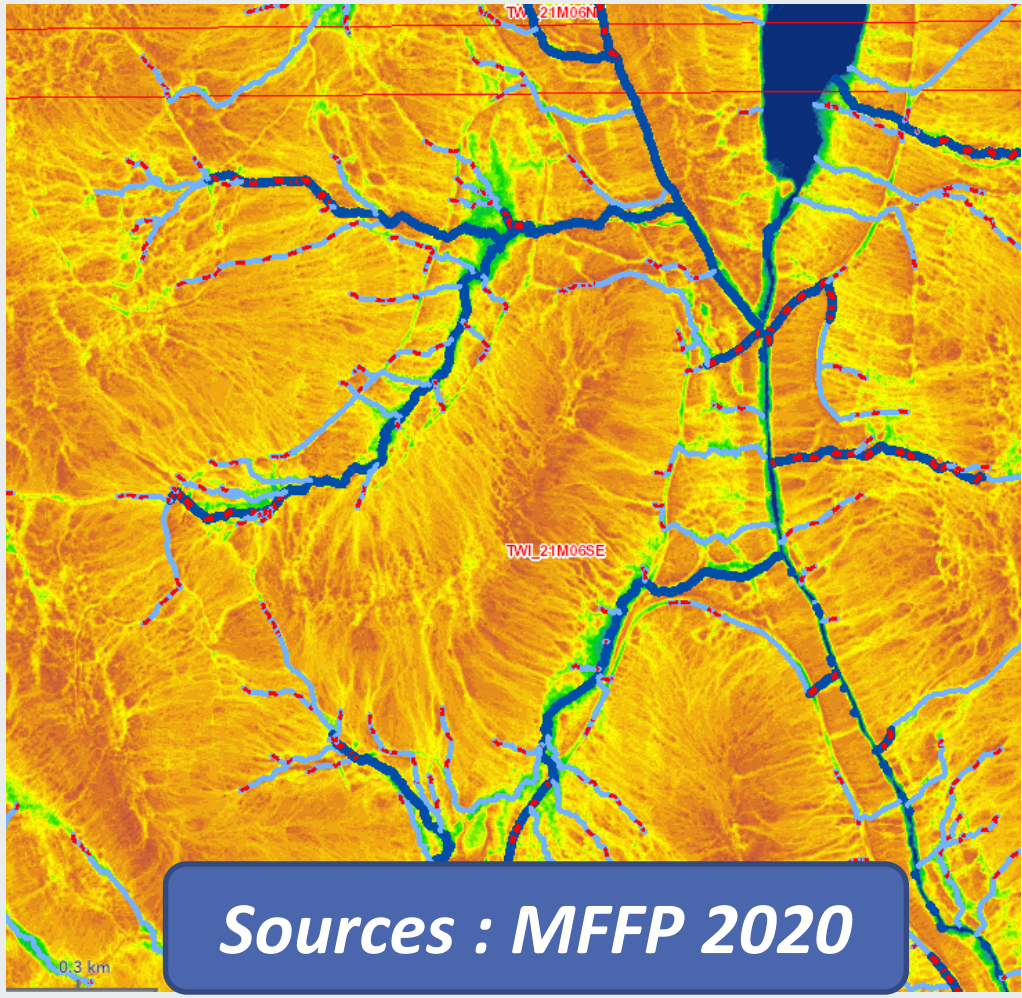
Lack of maintenance of road networks

- Direct threat to water quality
  - Inevitable aging of water crossings
- Quebec's "Sustainable Forest Management Strategy" - 2015
  - Protection of aquatic ecosystems
    1. New requirements of the regulation (RNI → RADF)
    2. Equivalent cutting area (ECA) – salmon rivers
    3. Forest road networks management policy

In 2021, still no monitoring of old forest roads and water crossings by the MFFP, nor the adoption of a road management policy

Solutions : High resolution mapping of streams and roads

- New mapping products available (2020)
  - > 300 000 km² Lidar DEM (1 m x 1 m)
    - Potential streambeds
    - Topographic wetness index (SagaWI)
  - Free download : donneesquebec.ca
  - Free display: geoapp.bibl.ulaval.ca
  - Gaspesia peninsula (April 2021)
- More to do with Lidar DEM
  - Geo-interpretation of roads
  - Geo-interpretation of culverts



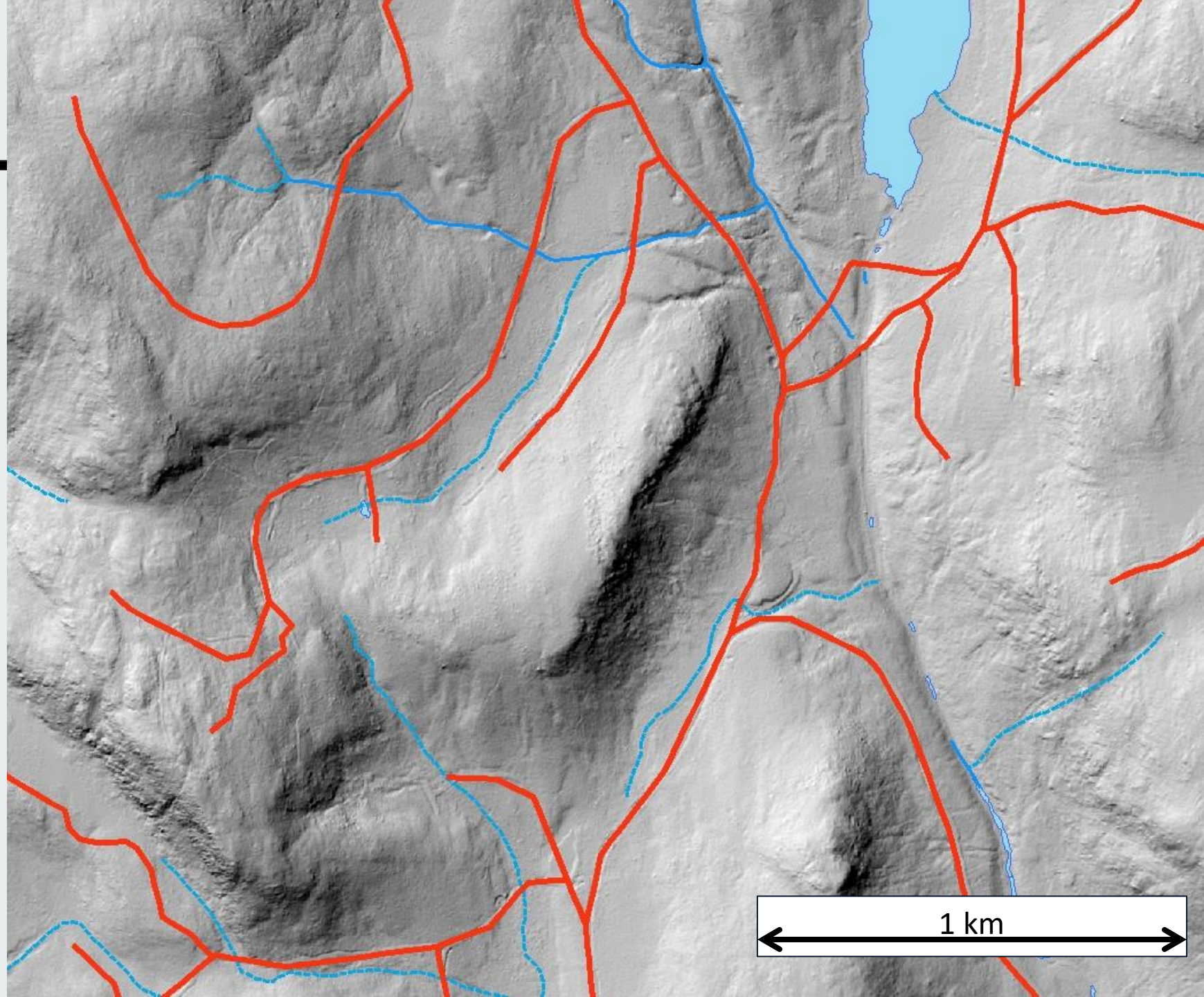
Photo


1 km
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

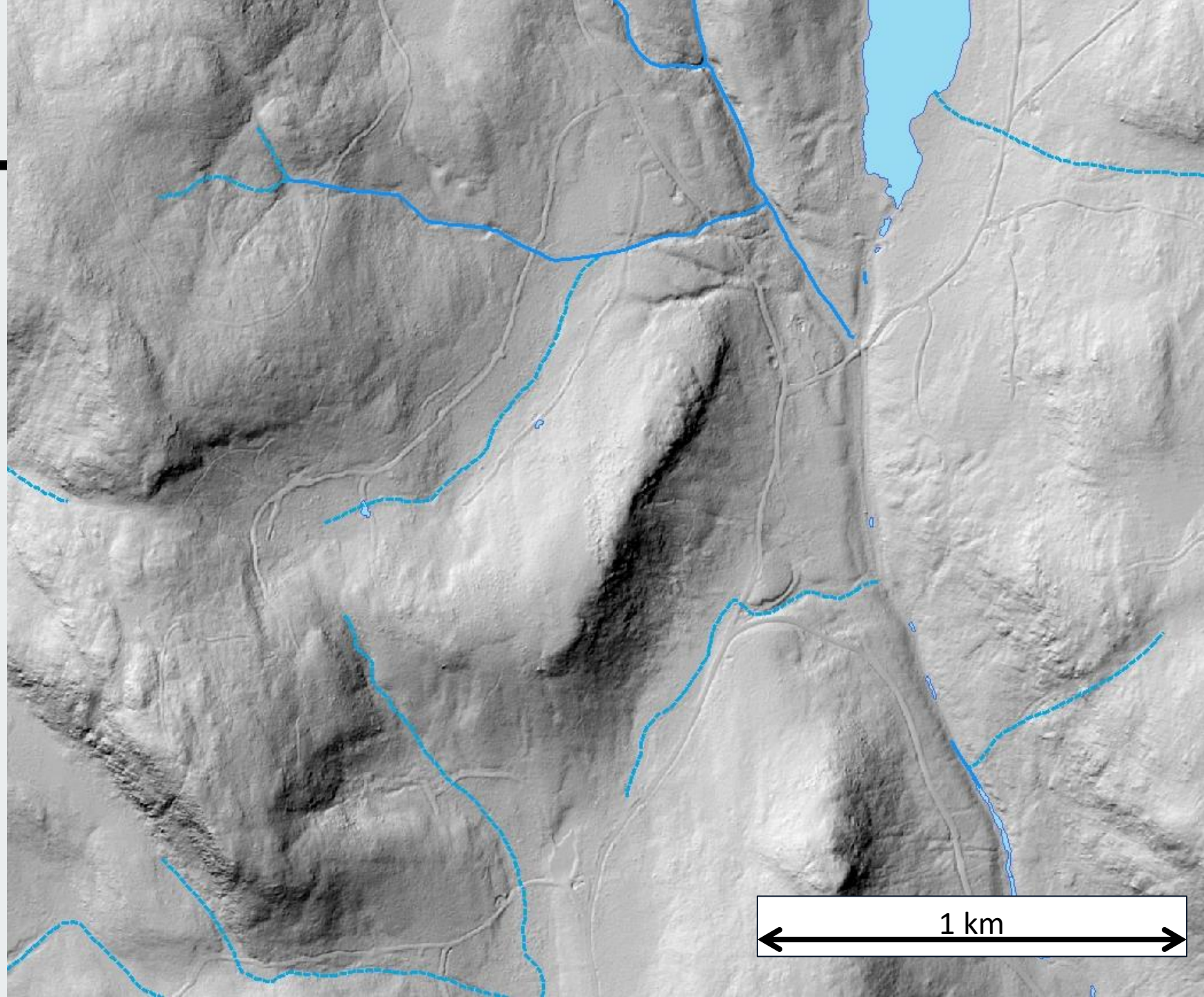
Photo Roads (4th NI)

Photo
Roads (4th NI)
Hydro (4th NI)

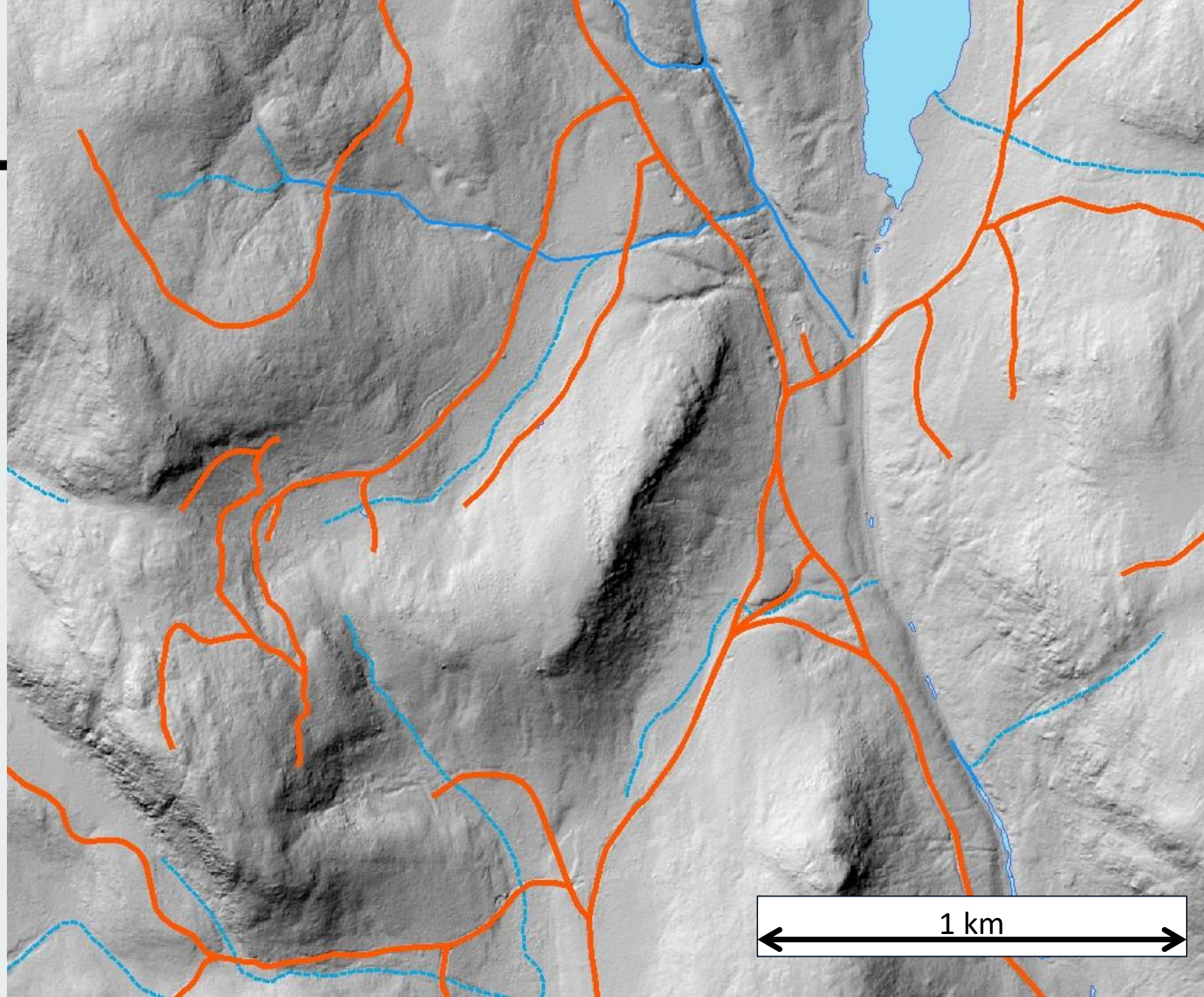
MNT Lidar
Roads (4th NI)
Hydro (4th NI)



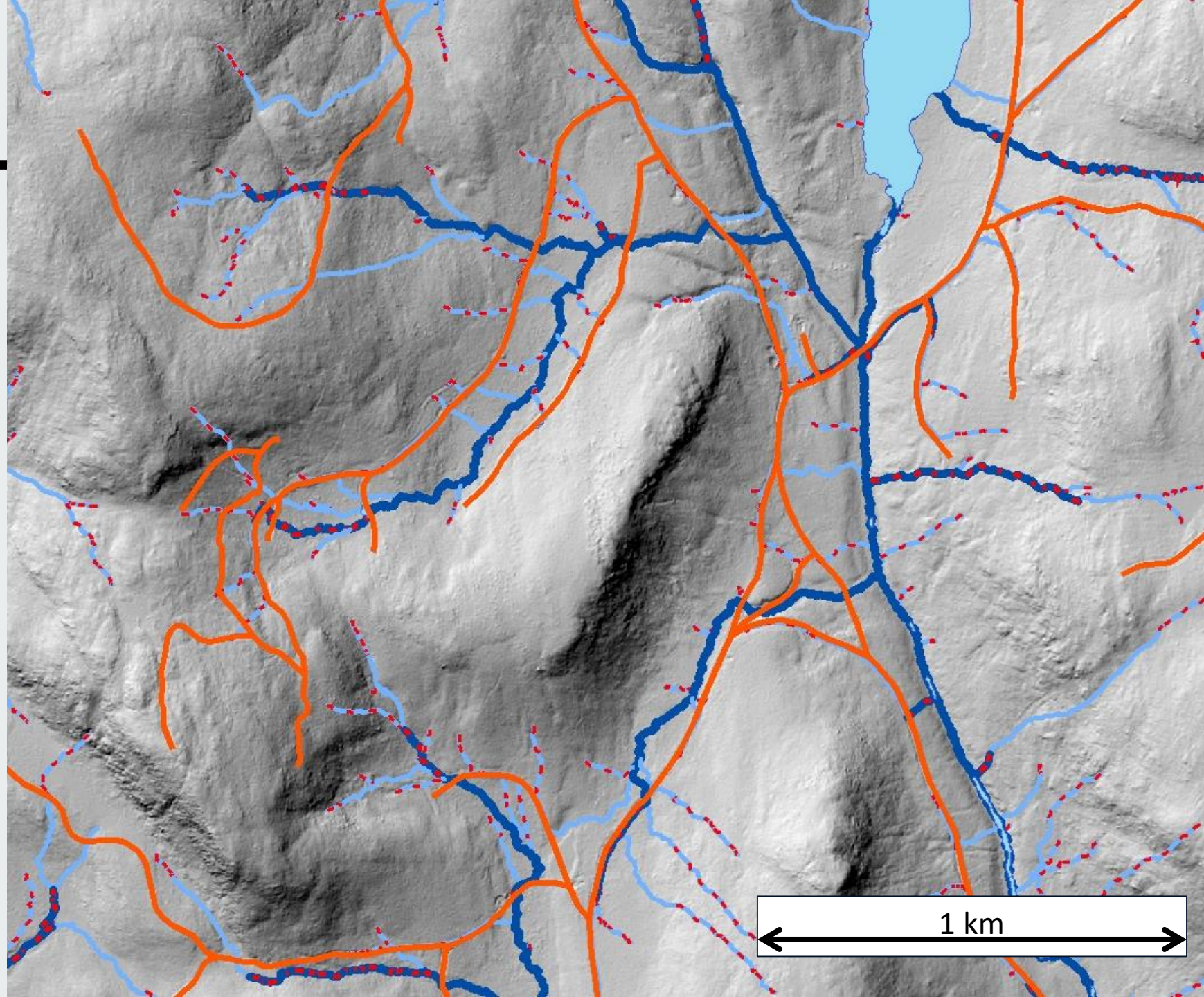
MNT Lidar
Roads (4th NI)
Hydro (4th NI)



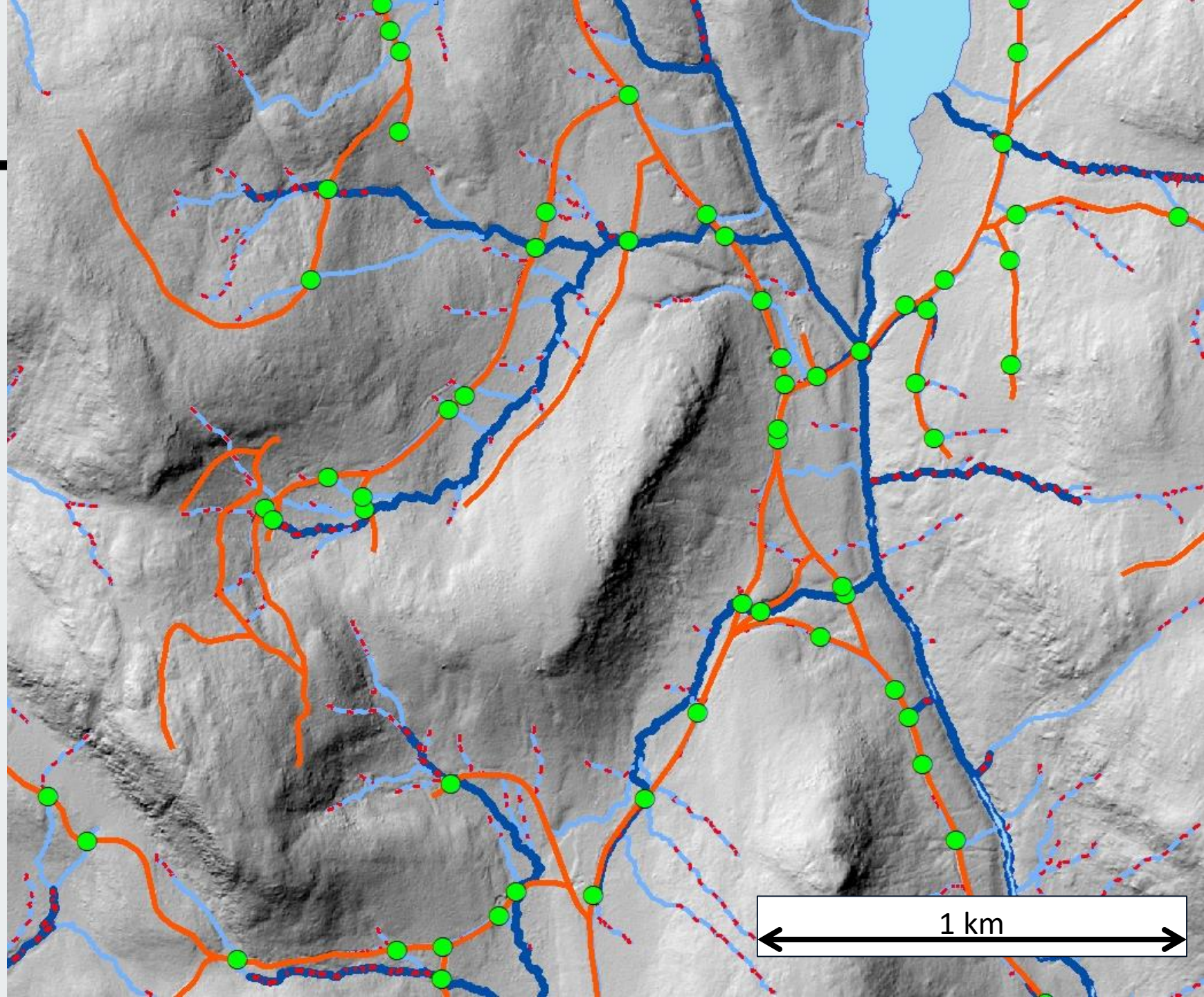
MNT Lidar
Roads Lidar
Hydro (4th NI)



MNT Lidar
Roads Lidar
Hydro Lidar



MNT Lidar
Roads Lidar
Hydro Lidar
Culverts Lidar



Solutions : Roads and water crossings

- Road and water crossing extraction by watershed
  - Efficient use of the concept of watershed management
    - Higher priority than ECA calculation
  - Road density by :
    - Road category (1, 2, 3, 4, 5, unknown, abandoned)
    - State of roads and ditches
    - Use and maintenance frequency
  - Water crossing density
    - State, maintenance needs, fish passage, etc.
  - Cumulative effects assessments (British Columbia is a good example)

Solutions : Road network management policy

- Integrated and exhaustive road network management policy
  - The MFFP has to take responsibility of water protection in public forests
  - Governmental database of road networks state on public land
    - Every road using Lidar DEM (even abandoned ones…)
    - Every water crossing (state and expiry date)
  - Development of new low-volume road management methods
    - Precise requirement for maintenance
    - Permitting decommissioning
      - Temporary bridges for temporary use
      - Improved rock fords
    - Facilitating and financing road closure

Solutions : Alternative water crossings

- Alternative tools for road network management
  - Open-bottom arch culvert

Solutions : Alternative water crossings

- Temporary bridges

Pascal Morissette 2017

Karelle Gilbert 2017

Solutions : Alternative water crossings

- Improved rock fords for low-volume road decommissioning

Sylvain Jutras 2018

Solutions : Alternative water crossings

- Fine sediment input to stream (< 2 mm)

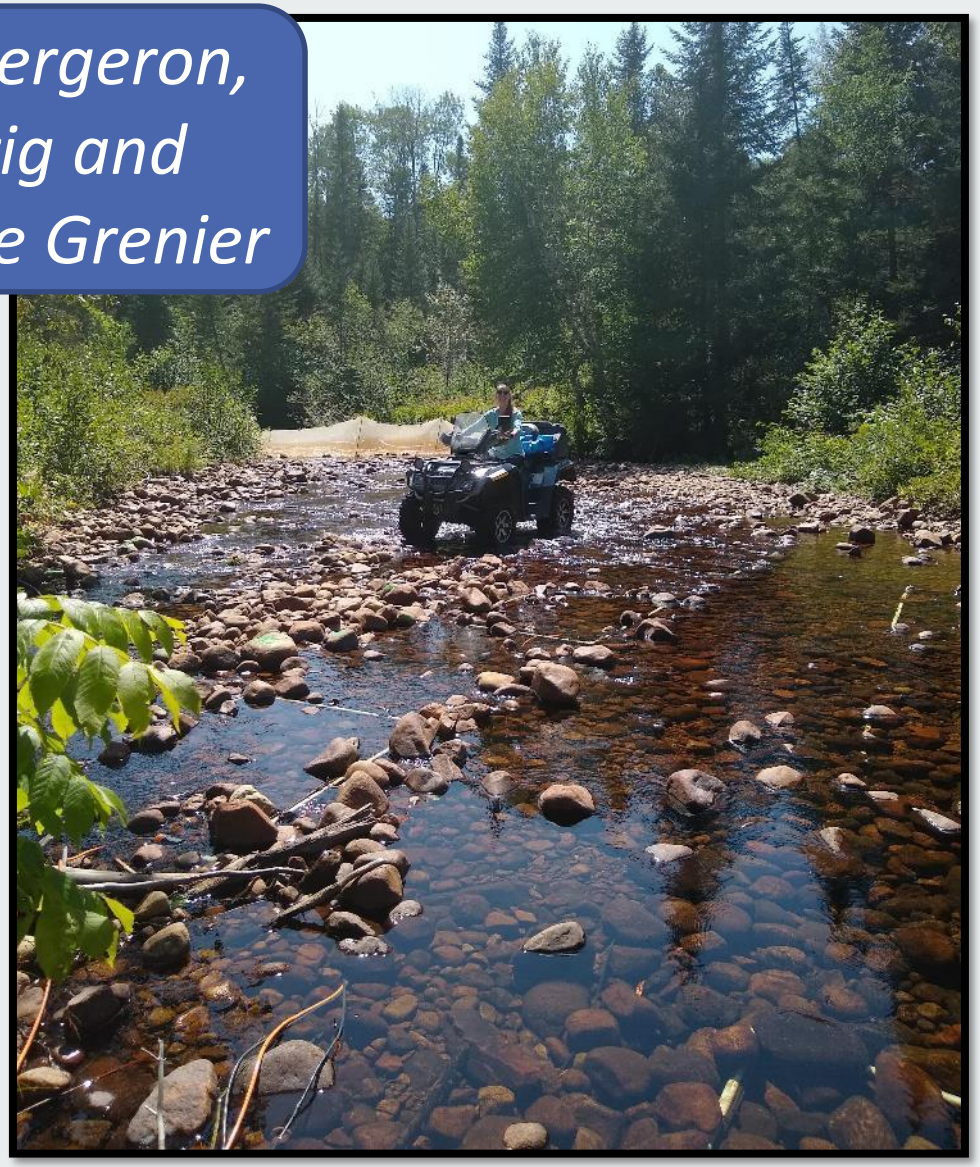
Sylvain Jutras 2018

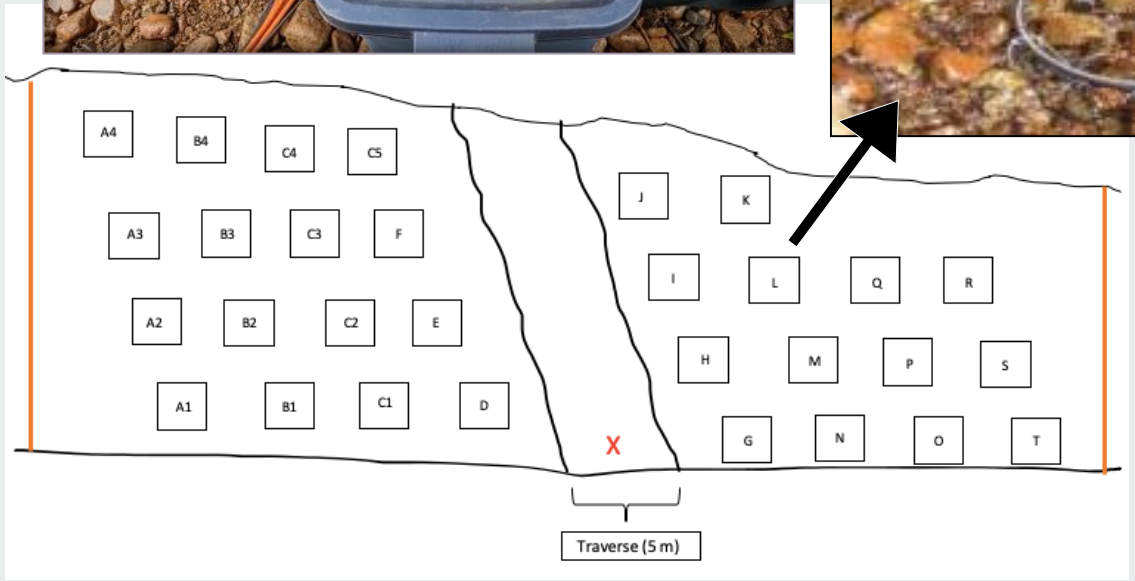
Solutions : Improved rock fords

Vidéo : Sylvain Jutras 2018

Solutions : Fords and fish passage

Normand Bergeron, Elsa Goerig and Audrey-Anne Grenier





Conclusion : Water and forest roads in Quebec

- Main issue :
  - External sediment input to streams
    - Harvesting using best management practices = effective protection of water
    - Lack of maintenance of road networks = considerable threat to water quality
- Solutions :
  - Integrated and exhaustive management policy of road networks
    - Lidar-derived mapping of road and water crossings
    - New road management methods are needed