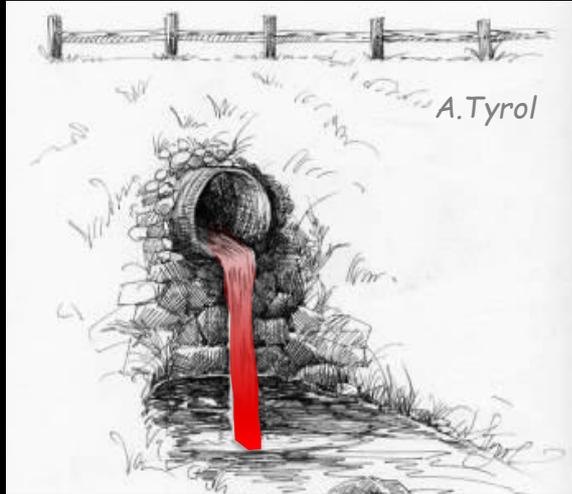


# Death by a million pipes



## an overview of culverts in Europe

Carlos Garcia de Leaniz &  
AMBER Consortium



**Rivers are  
meant to  
flow.....**



**But  
most  
don't...**



99.9%



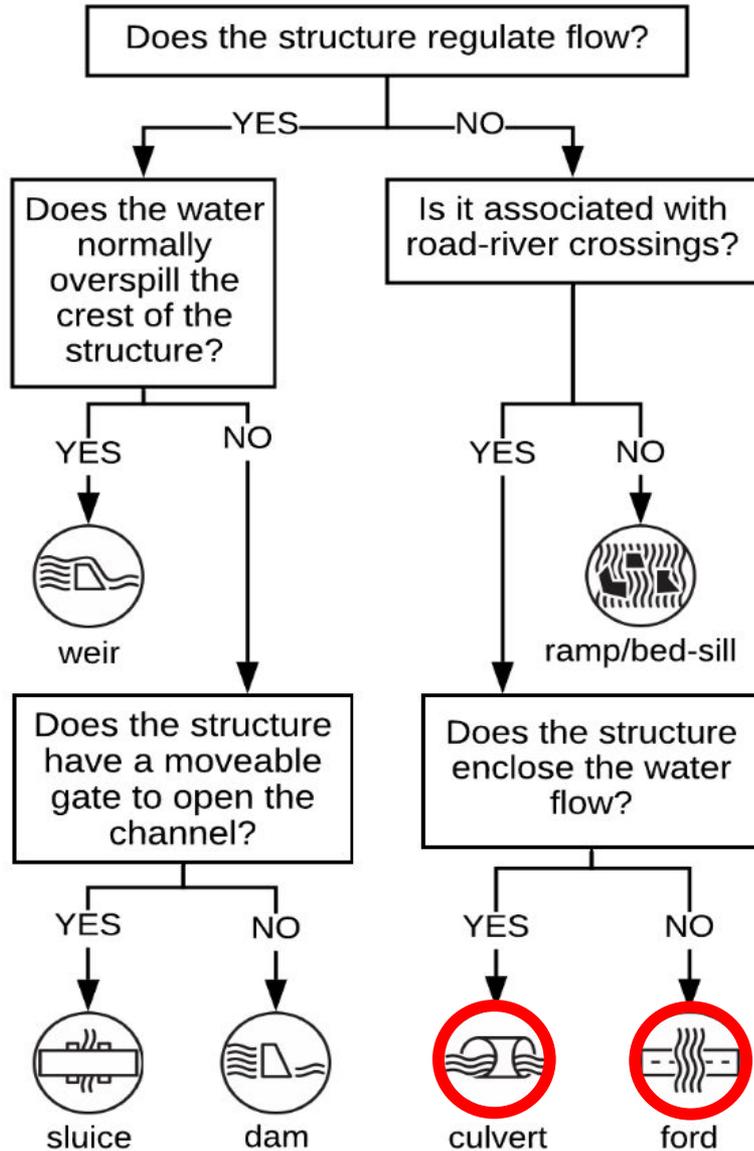
0.1%



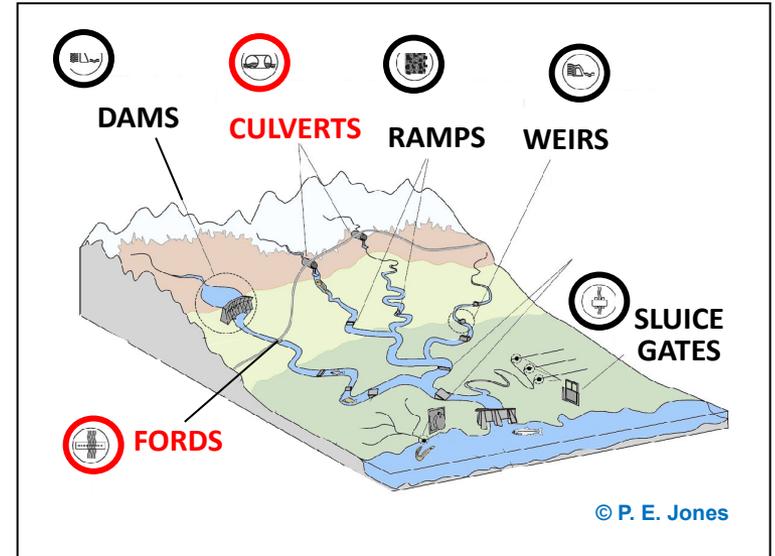
and large dams are not  
the biggest problem....  
it might be culverts

# Barrier typology: what is a culvert

**Ponding**  
Store water



**Non-ponding**  
Don't store water



**Non-ponding structures at river-road crossings**

How many  
[hidden]

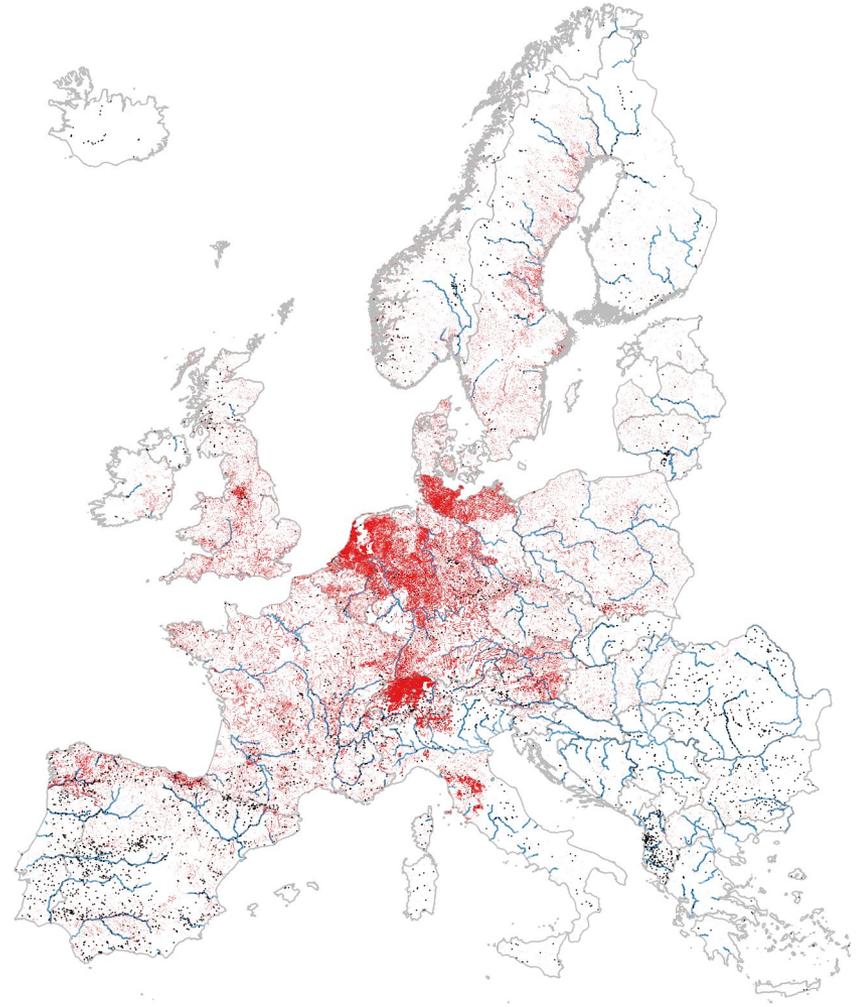
culverts are in  
Europe



# What we do know (sort of...)

**+1.2M**  
**barriers**  
but.. could be  
as high as

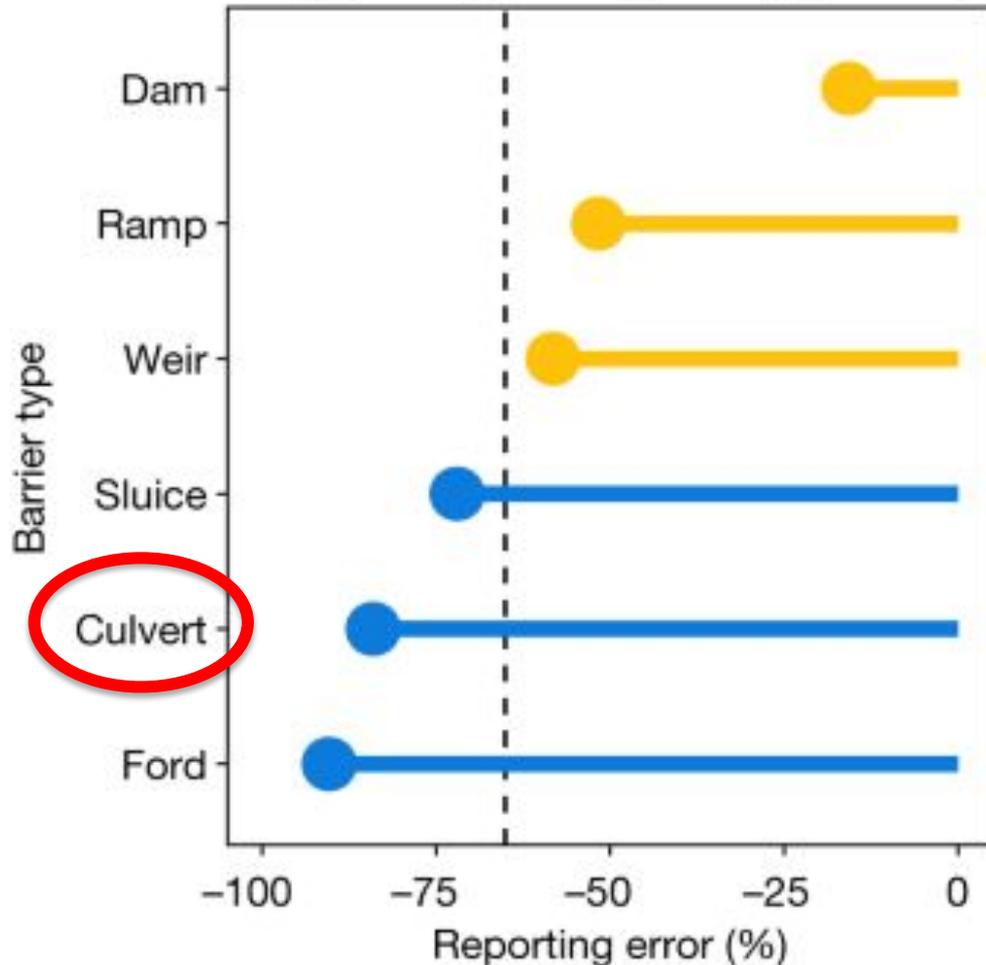
**3.7M**  
**barriers**



Belletti et al (2020) *Nature*

# Culverts are under-reported...

Belletti et al (2020)

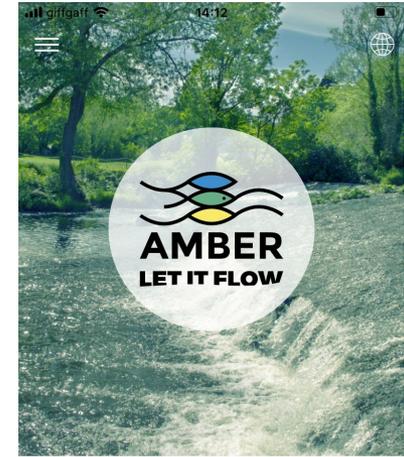
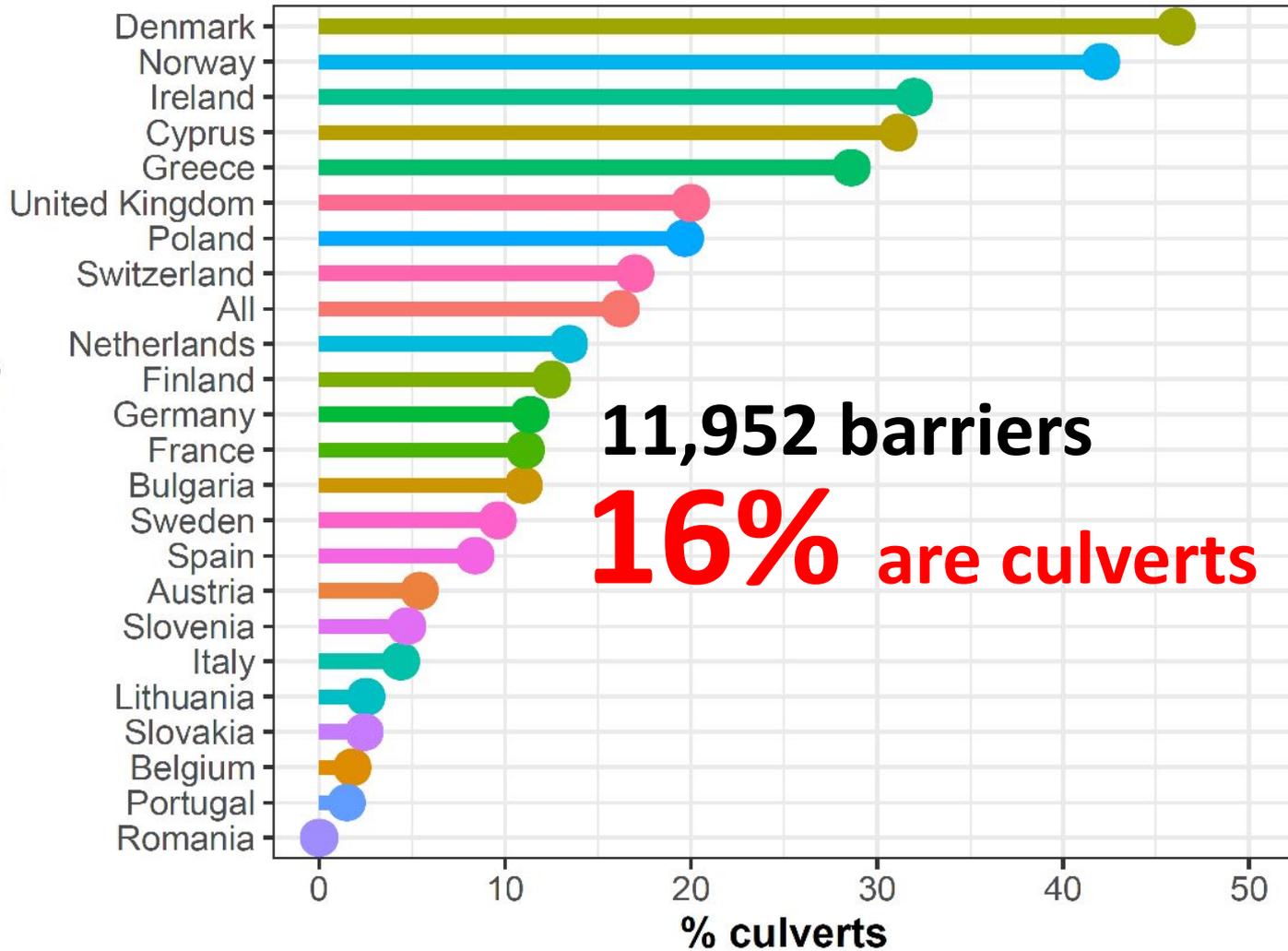


**Atlas = 111K**  
culverts

**but...**

**- 84%**  
**error**

# Citizens are finding culverts everywhere..

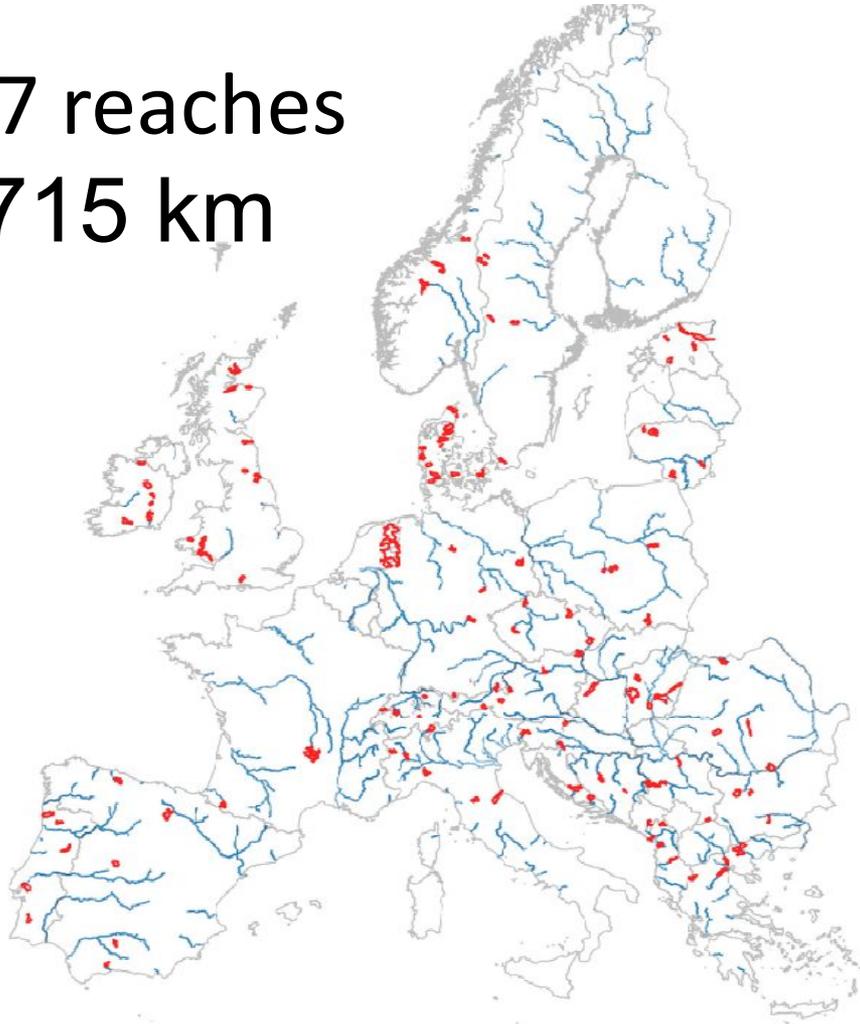


Record a New Obstacle

View Map

# But culverts aren't randomly distributed...

147 reaches  
2,715 km



1,583 barriers

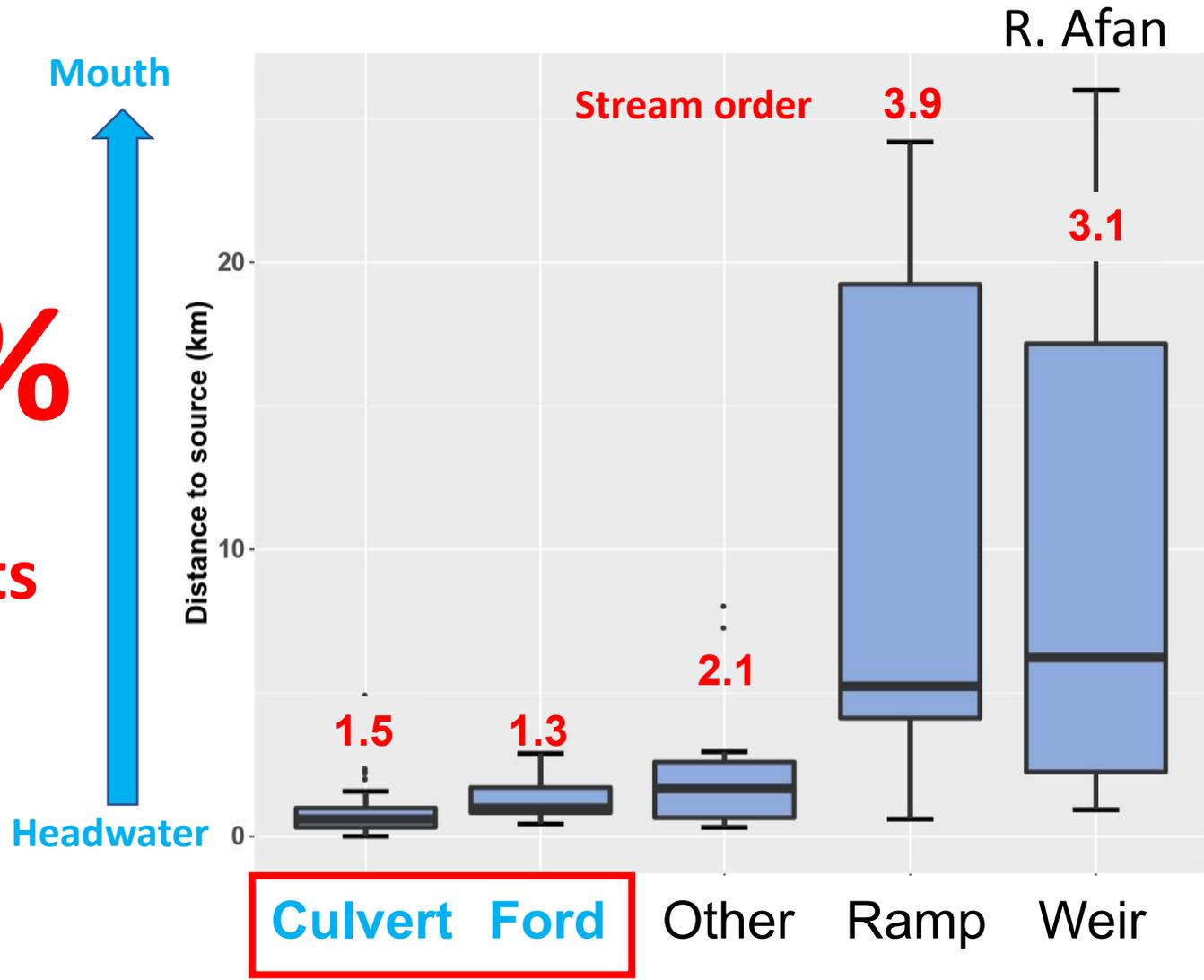
**4%** are  
culverts

But... if consider only  
**1<sup>st</sup>-2<sup>nd</sup> order streams**

**49%** are  
culverts!

# Culverts dominate low order streams

**51%**  
are  
culverts



# But can we estimate their number

$$N = \frac{n}{l} * L$$

*No. culverts* = *culvert dens.* \* *River network*



**BIG, BIG**

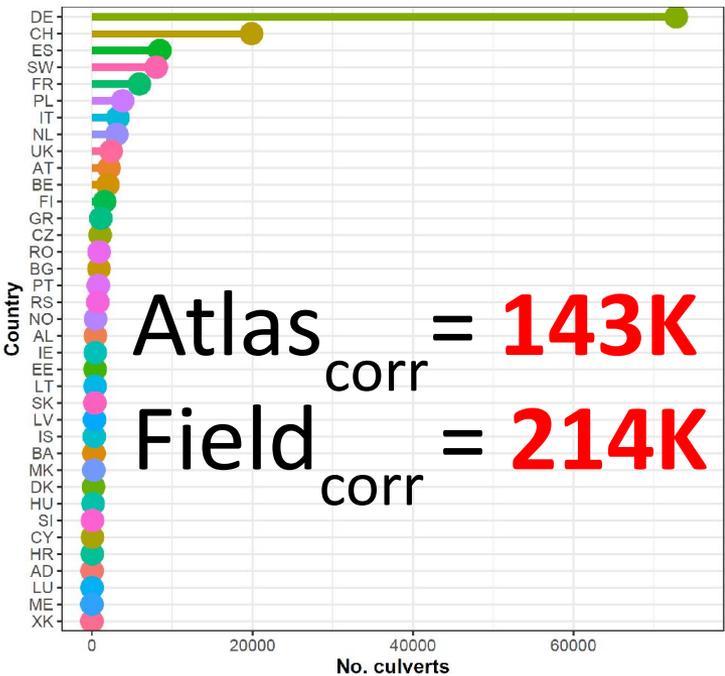
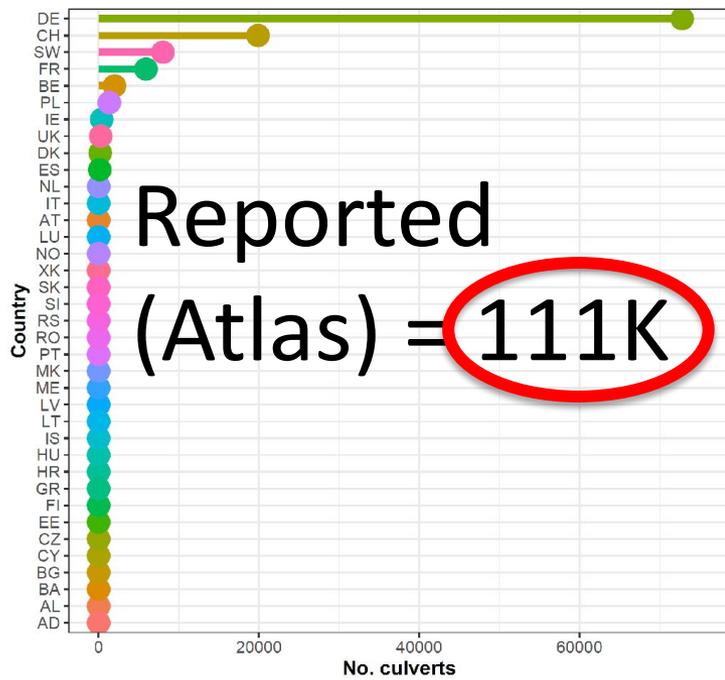
uncertainty



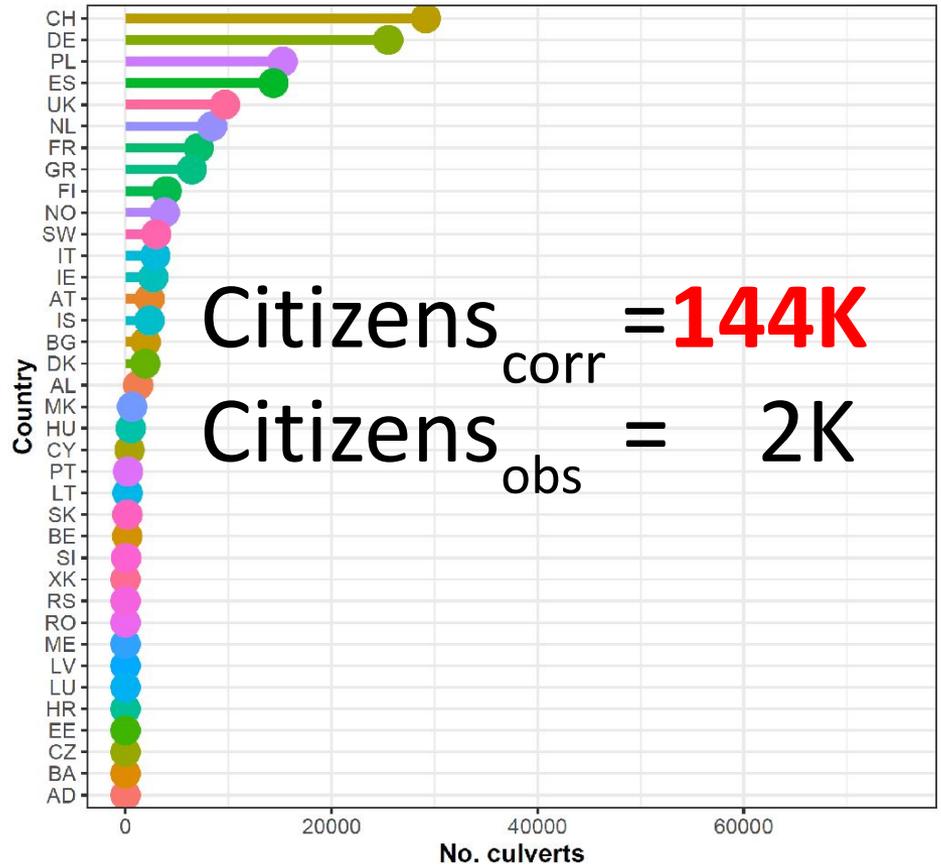
**BIG** error



**BIG** error



We can try...



But culverts are only found in small streams.. hence easy to miss

# Estimates based on small streams

*No. culverts* = *culvert dens.* \* *River network*



0.125 culverts/km  
in 1<sup>st</sup>-2<sup>nd</sup> order  
streams<sup>1</sup>



80% of 5M km  
are 1<sup>st</sup>-2<sup>nd</sup> order  
streams<sup>2</sup>

**0.125 x 0.8 x 5 x 10<sup>6</sup> = 0.5M culverts?**

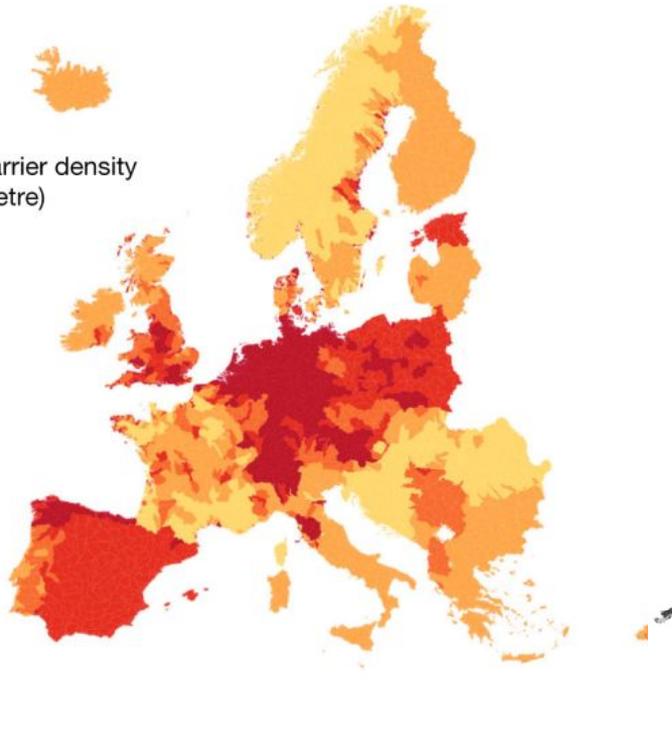
[This would be more than double our  
previous 200K estimate!]

<sup>1</sup>Belletti et al 2020; <sup>2</sup>Kristensen & Globevnik 2014

# Another approach: using road crossings

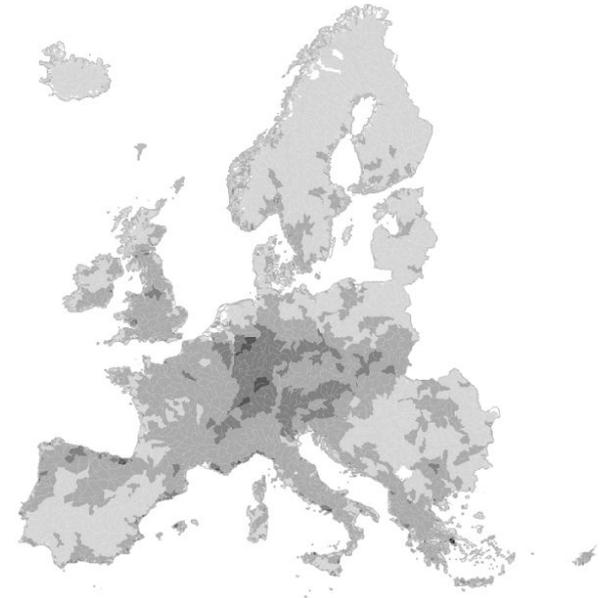
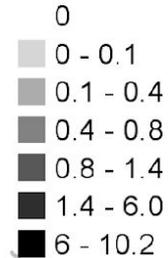
**b**

Field-estimated barrier density  
(barriers per kilometre)



**c)**

Road  
crossings  
density  
(No./km<sup>2</sup>)



Belletti et al (2020)

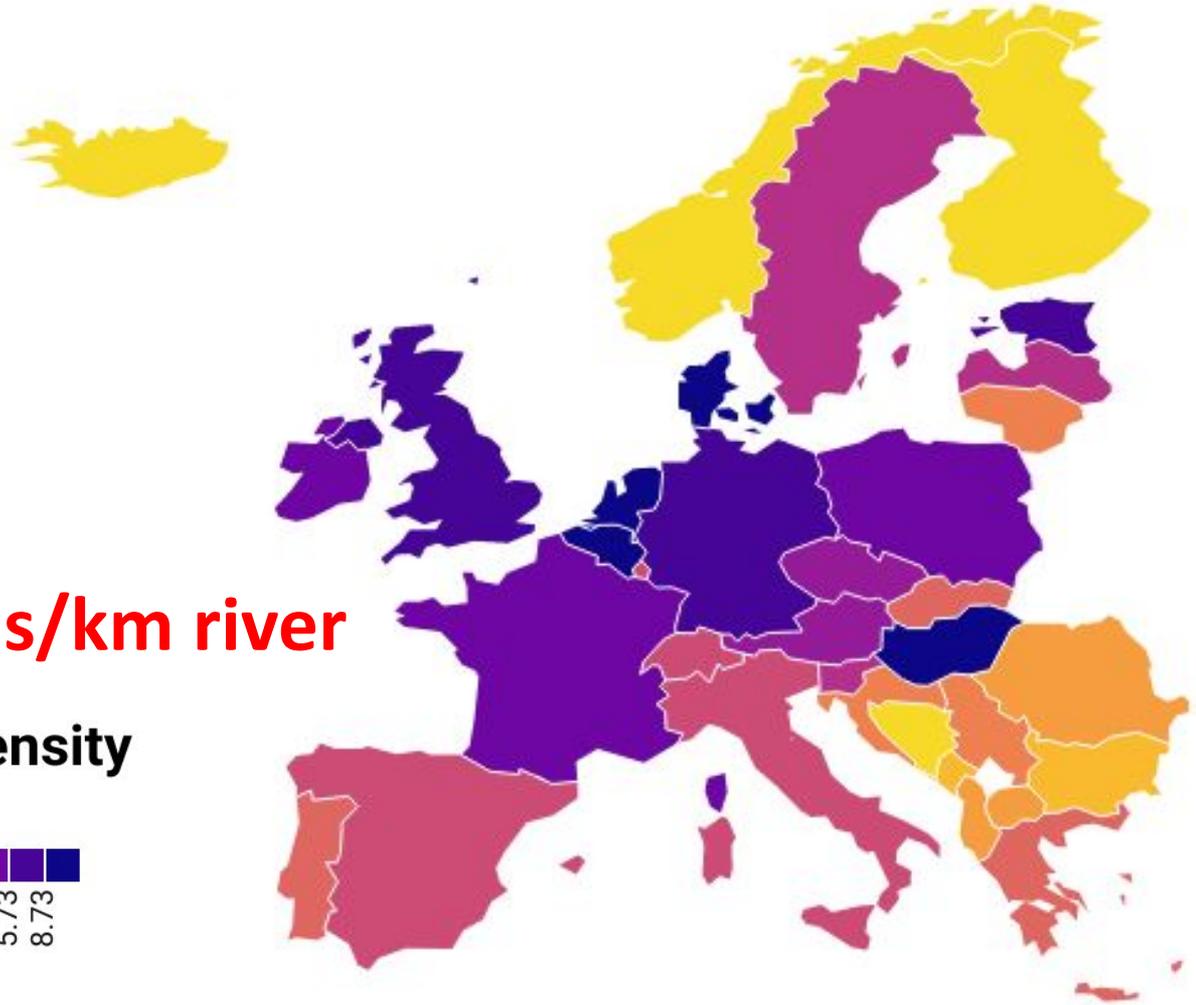
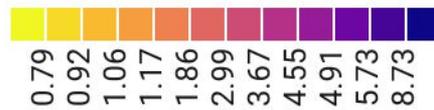
River road crossings are a good predictor of  
barrier density

# Road-river density

**3.8** km roads/km river

## Road/River density

km road/km river



# Very rough potential culvert estima

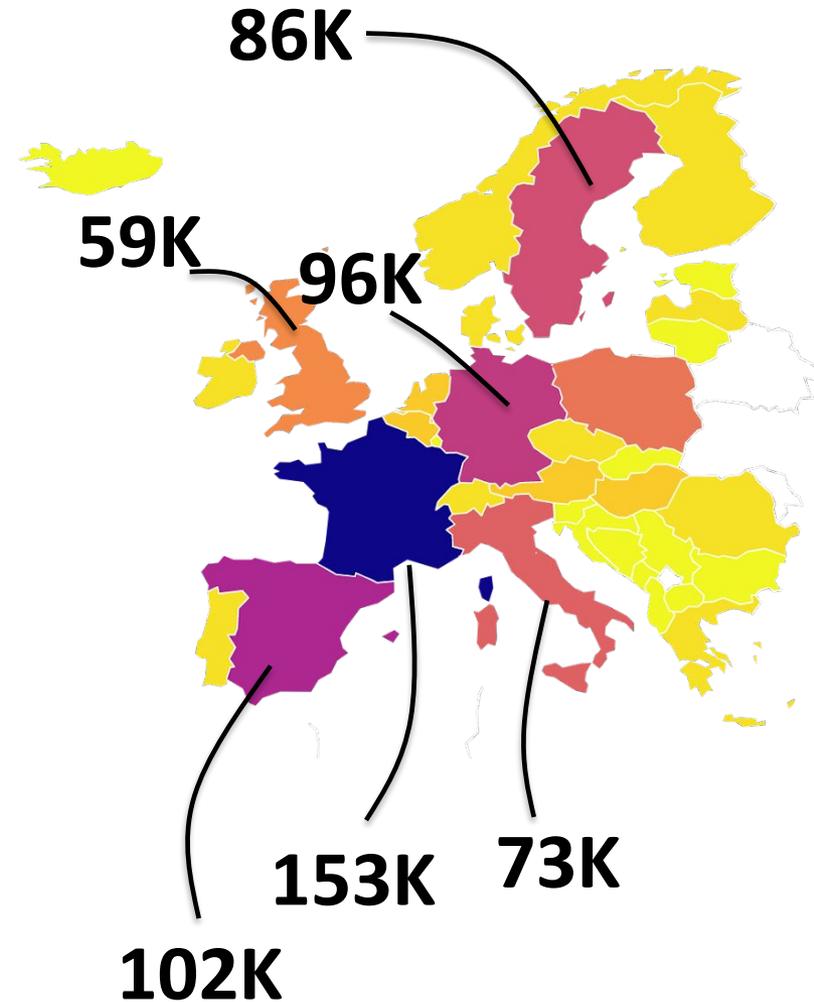


\* Scaling up number of river-road crossings from density of river and road networks

# Are 930K culverts conceivably possible?

## Some comparative data

- GB = 50K culverts (Steph), we predict 59K
- Great Lakes (+20 times smaller) has 250K culverts
- Germany has 51K bridges, we predict 96K culverts
- France has 200-250K bridges, we predict 153K culverts



so...culvert

s

abound,

(other than revenue & net profit -> next talk  
what

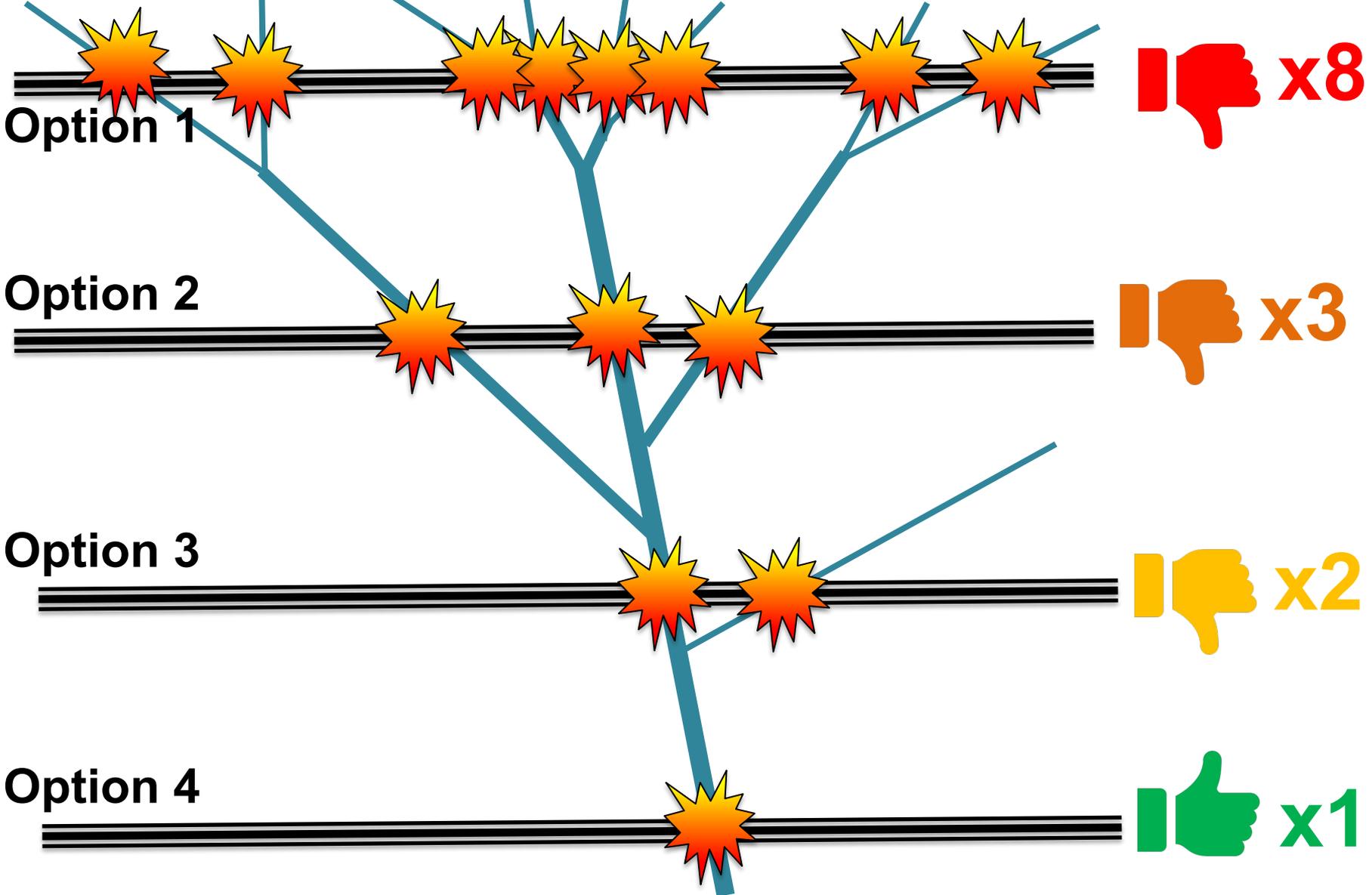
10

# 1. Plan future roads to reduce river crossings

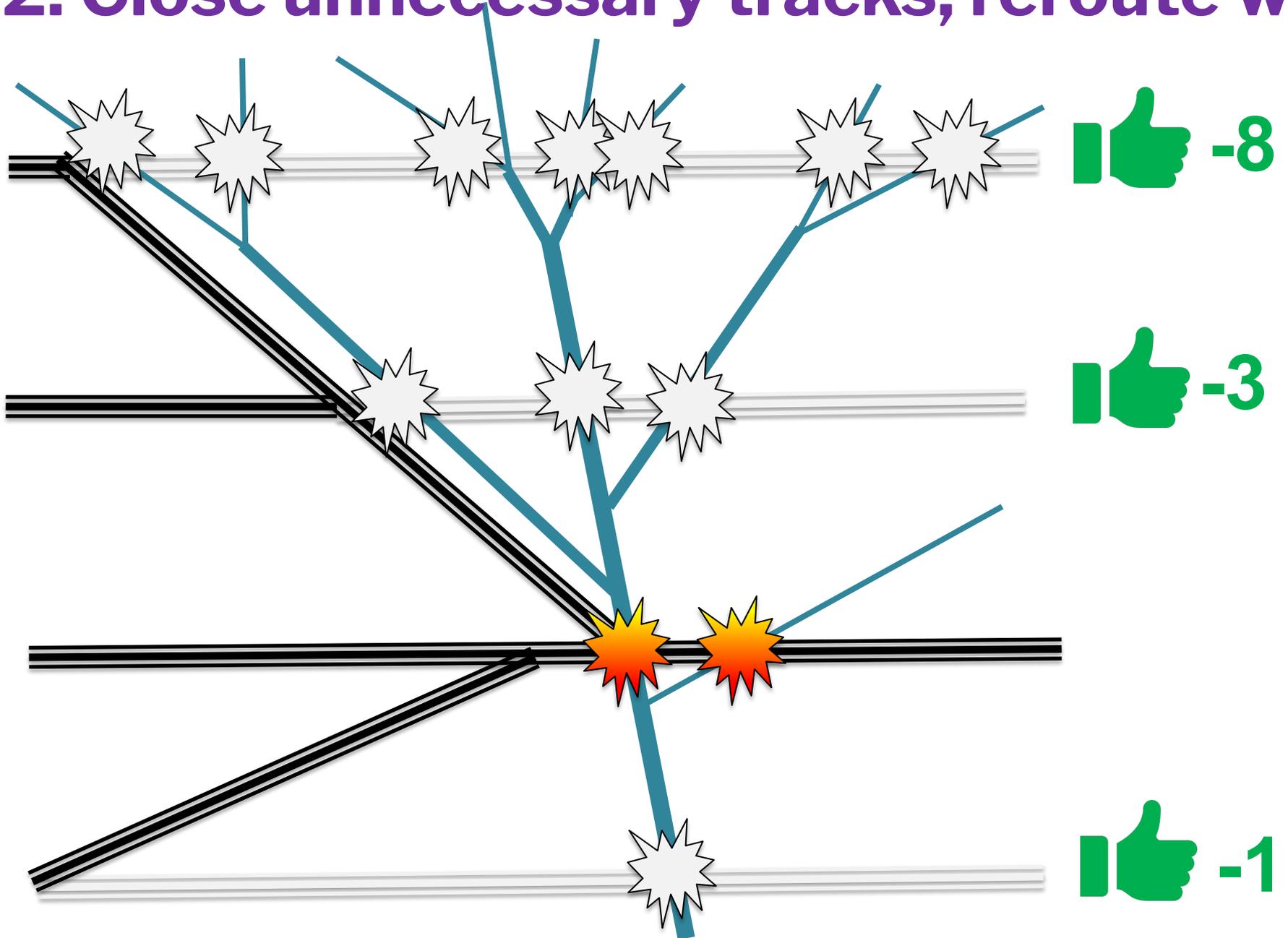
## Motorways in Europe



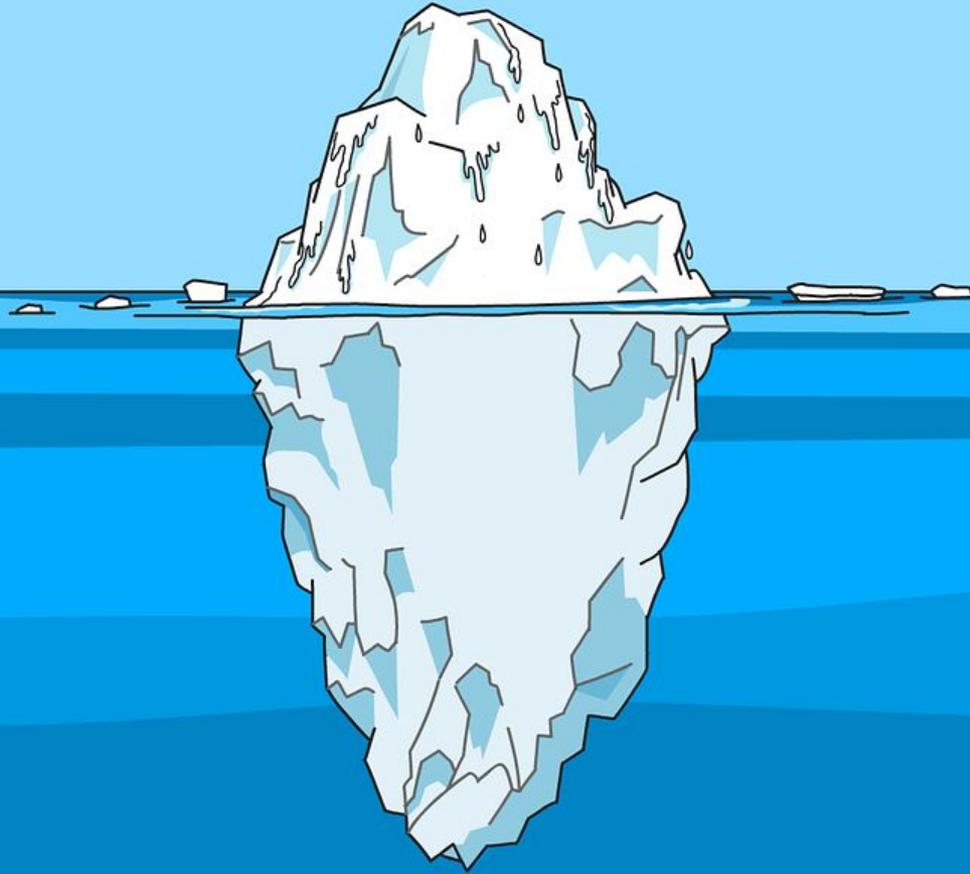
# 1. Plan future roads to reduce river crossings



## 2. Close unnecessary tracks, reroute wise



# 3. Raise awareness



### 3. Change their name



# Culbergs

**Thank  
you**

**90% invisible...  
yet lethal** 