LIFE SAFE CROSSING
PREVENTING ANIMAL-VEHICLE COLLISIONS

"LIFE-SAFECROSSING in Greece: Analysis and mapping of crossing structures on highway A29 and activities to enhance connectivity through interventions on underpasses and road sides".

LIFE11BIO/IT/072-LIFE17NAT/IT/464

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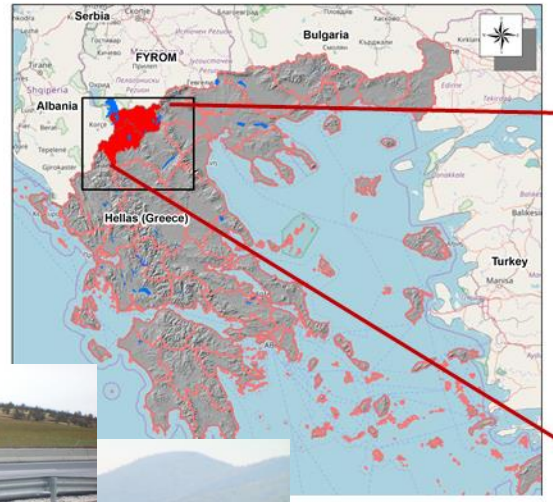
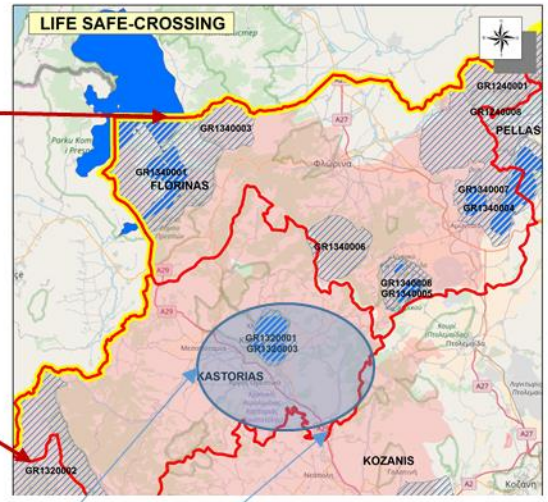
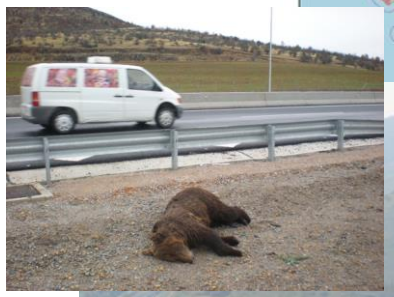
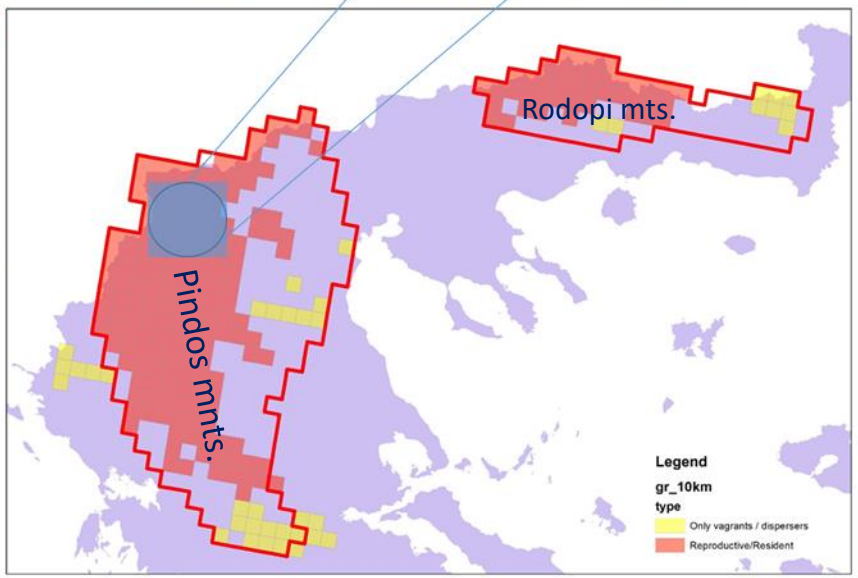
Study area









Project area : Regional Units of Florina and Kastoria.

Target species: Brown bear (*Ursus arctos**)

Study area : Regional Unit of Kastoria (bear min. population size estimated at **219** ind. *Tsaparis et al. 2014*).

Study area is part of the **Pindos mts**. brown bear distributional range in GR -> ~**450** ind. min, ~22,000 km2 of distribution area.

Study area: A29 Egnatia highway stretch – **55**km- cuts through bear habitat – (**21**) bear car collisions from 2009-2013 – *bear/proof fence installed in 2014* – (**149**) crossing structures.

Main objectives (Actions A4 & C2)

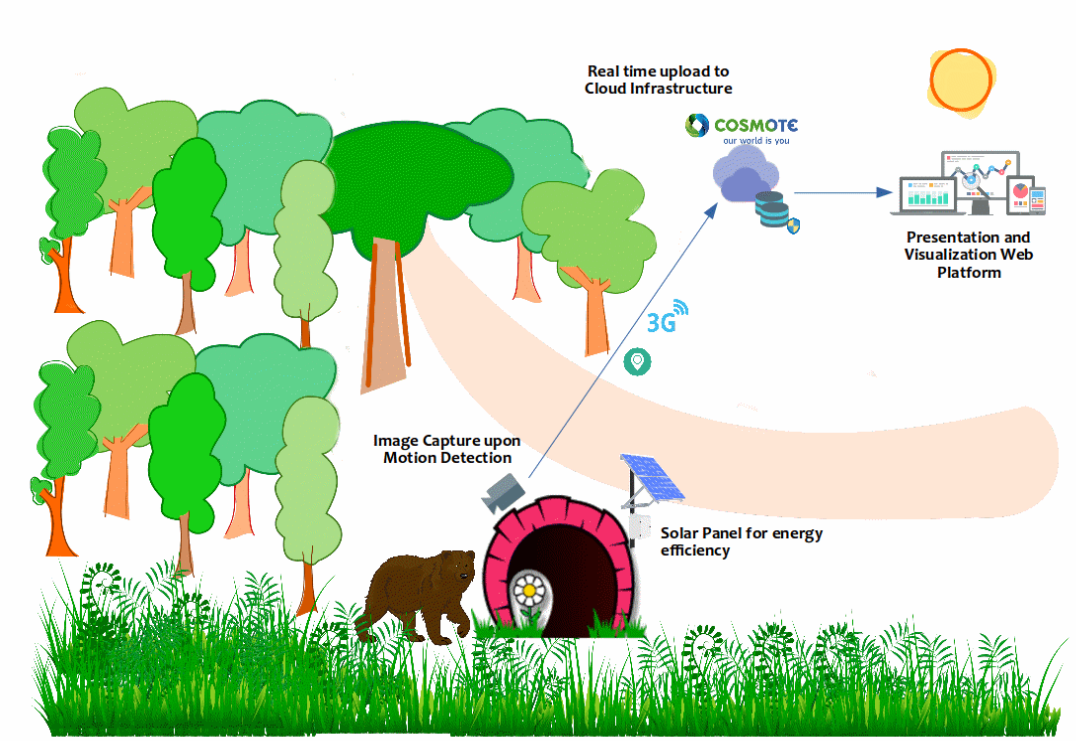
- **Identification through intensive monitoring and standardized typology of the existing Crossing Structures (CS) along highway A29 vs their frequency of use by target species (*Ursus arctos* *) (A4)**

- **Definition of appropriate/specific adaptations of CS's in order to maximize their attractiveness to target species & wildlife. (A4)**

- **Effective interventions of different types on the ground in order to improve selected CS's attractiveness and functionality. (C2)**

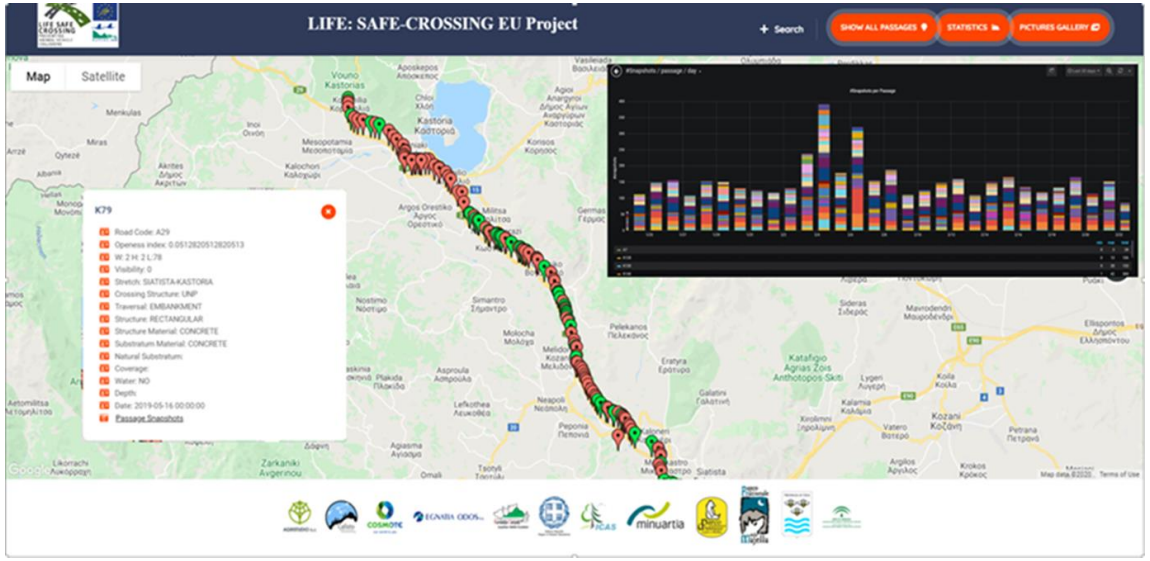
- **In the GR context: overall improvement of highway A29 permeability to wildlife and more specifically to *Ursus arctos**.**

Materials & methods: CROSSING STRUCTURES/cameras monitoring system (COSMOTE)



Features

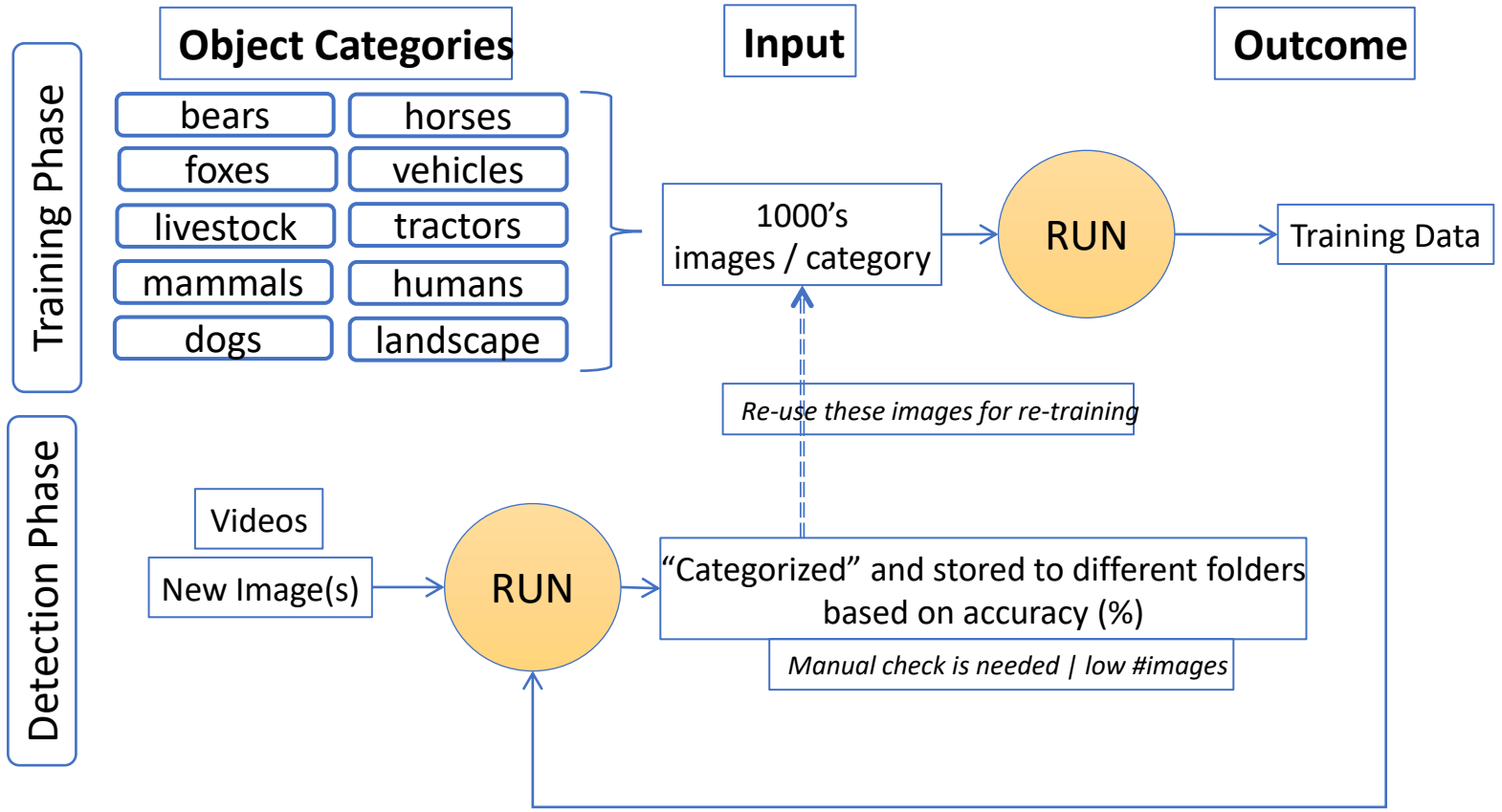
- **24x7 monitoring for wildlife presence @underpasses** incl., automated detection of objects/species passing, data storage @camera and @ COSMOTE's cloud infrastructure (3G/4G network)
- **Automated procedures** for snapshots' storage @cloud
- Snapshots' visualization through an **intuitive, user-friendly web portal** (incl. underpass info, snapshots/ underpass, statistics, etc.)
- **Tools for automated spices/object detection and categorization**
- **Near real-time "presence" alerts** (see push notifications) to mobile devices
- **Tools for zero touch statistics/graphs:** #snapshots/day/week/…/underpass, #spieces per underpass, etc.



Materials & methods: CROSSING STRUCTURES/monitoring data management (COSMOTE)

"Object"/Species Detection/Identification/Classification Tool

The tool, utilizing machine learning techniques, processes automatically snapshots, detects the "object"/species/taxa with high accuracy and saves the snapshot to the relevant taxon/object/specific folder, thus minimizing the manual effort. (**n= 71,695**) (**12 months monitoring session**)



Materials & methods: CROSSING STRUCTURES/detailed typology

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Identification and location of the structure	STRUCTURE CODE: (TYPE_RoadCode_PK) ex: MUP_A2_55+100
Road code: ex: A2	**PK:** (kilometre point; 000+000) ex: 55+100
Road stretch: (town to town) ex: *Brasov-Comarnic*	**Coordinates (X,Y):** (If GPS location is not provided)

Main structural features

Type of non-wildlife crossing structures (With NO particular adaptations for wildlife)	Type of Wildlife crossing (Specific for wildlife or adapted to allow fauna use)
	☐ Ecoduct (ECO)
☐ Tunnel (TUN)	☐ Wildlife Overpass (WOP)
☐ Overpass (OVP)	☐ Multi-use Overpass (MOP)
☐ Viaduct (VIA)	☐ Wildlife Underpass (WUP)
☐ Underpass (UNP)	☐ Multi-use Underpass (MUP)
☐ Culvert / drainage (CUV)	☐ Modified culvert (WCU)
☐ Other:	☐ Amphibian tunnel (ATP)

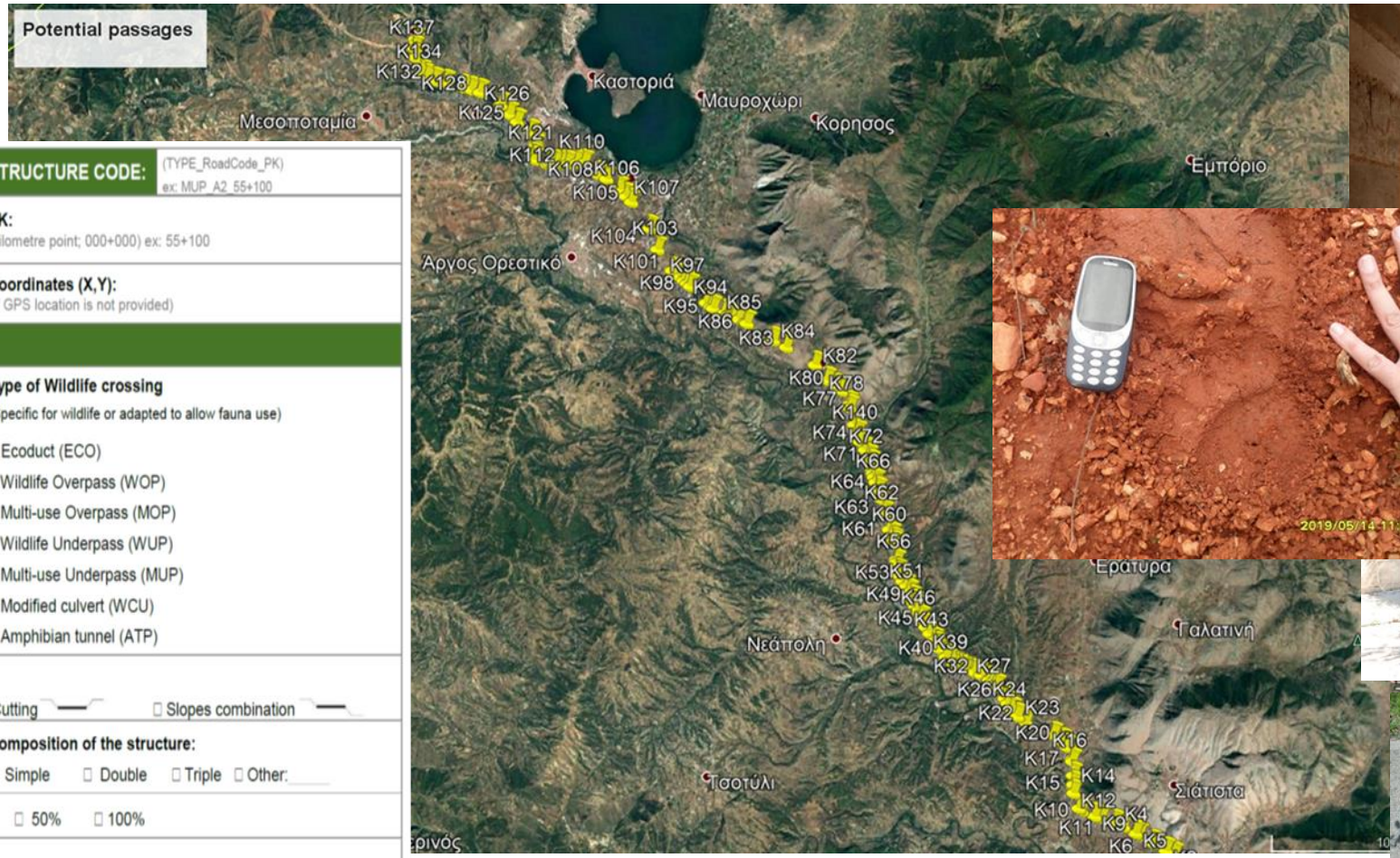
Road transversal section:
☐ Flat ☐ Embankment ☐ Cutting ☐ Slopes combination

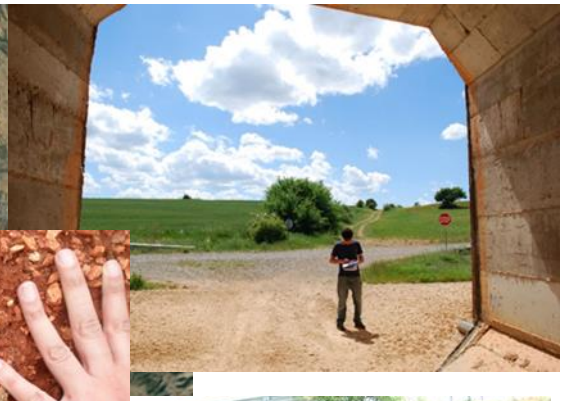
Structure section:	Composition of the structure:
☐ Circular ☐ Rectangular ☐ Vault ☐ Other:	☐ Simple ☐ Double ☐ Triple ☐ Other:

Visibility of opposite entrance: ☐ 0% ☐ 25% ☐ 50% ☐ 100%

Dimensions (m):
Height (H): Width (W): Length (L): Openness Index (Section/L):

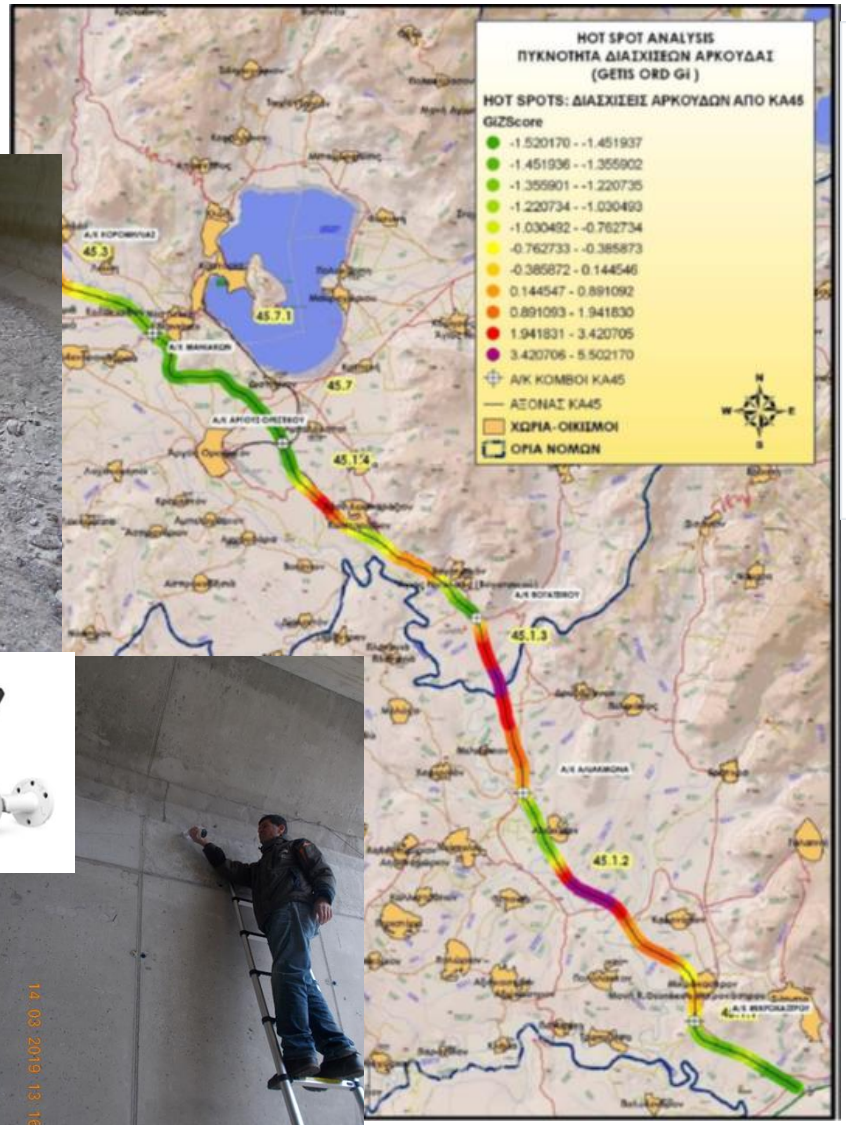
Multicellular
Height (H): Width (W=W1+W2): Length (L): Openness Index (Section/L):

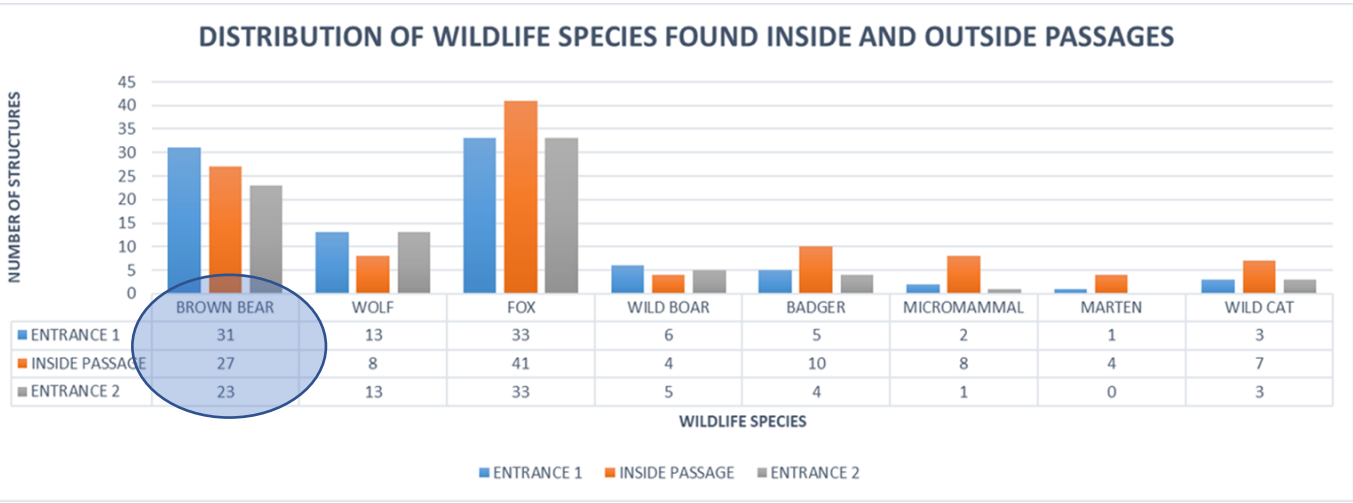




- **149 underpasses on A29 checked/standardized field form (*Minuartia 2020*)/data base**

Materials & methods: CROSSING STRUCTURES/cameras monitoring system installation





	BROWN BEAR	WOLF	FOX	WILD BOAR	BADGER	MICROMAMMAL	MARTEN	WILD CAT
ENTRANCE 1	31	13	33	6	5	2	1	3
INSIDE PASSAGE	27	8	41	4	10	8	4	7
ENTRANCE 2	23	13	33	5	4	1	0	3

45 video/cameras installation at **45 CS**

CS's Selection criteria:

(a) presence of bear signs during **typology** field survey

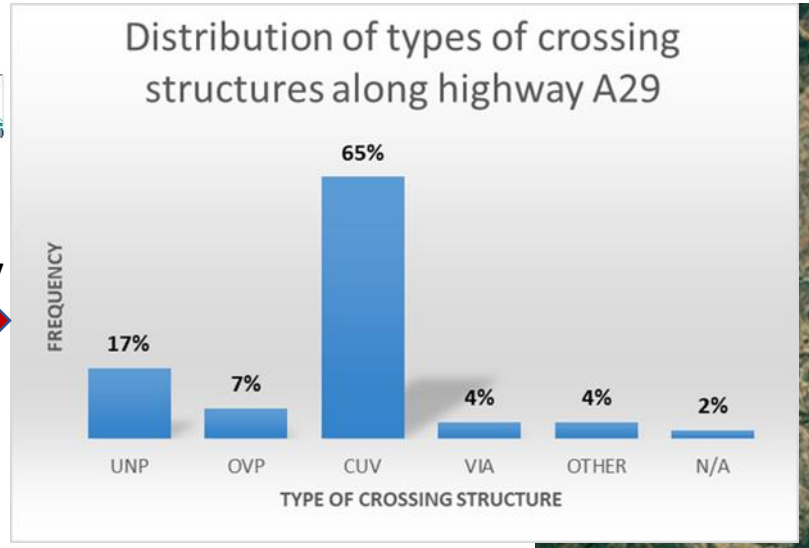
(b) "Hot spot" analysis of pre-existing bear telemetry data, bio-signs, road mortality data (project:*LIFE09NAT/GR/00333 & action A3 under this project*)

(c) expert opinion

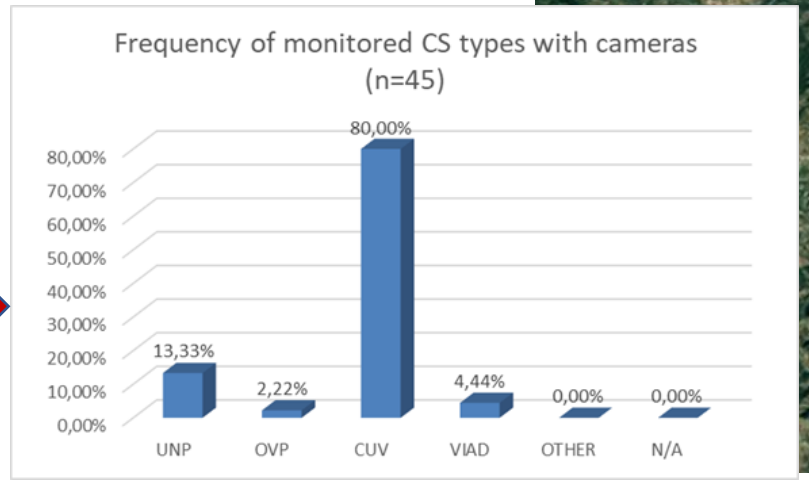
(d) Technical reasons (need of 3G/4G coverage @ CS's with cameras).

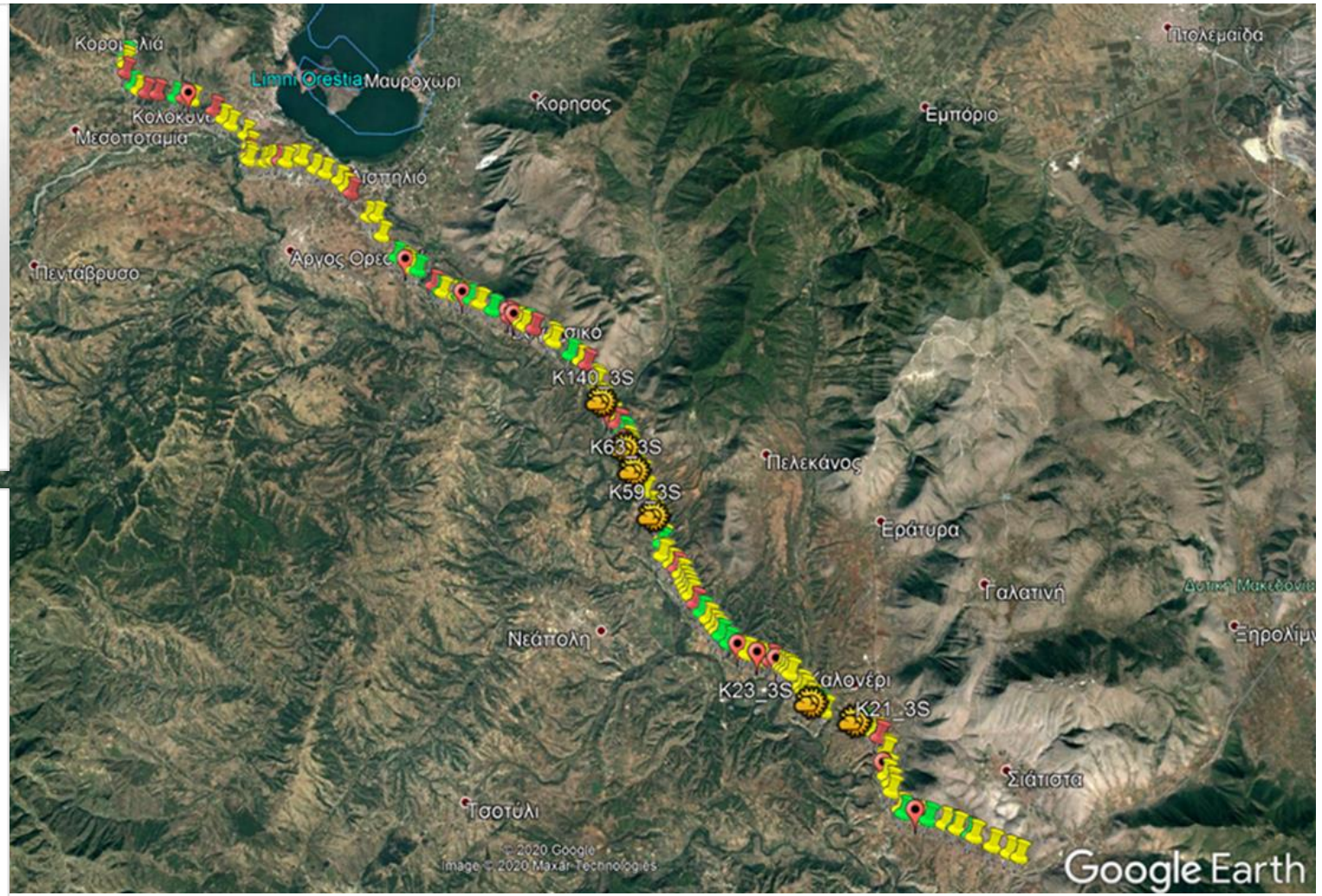
Materials & methods: CROSSING STRUCTURES/cameras monitoring system installation

availability



monitored



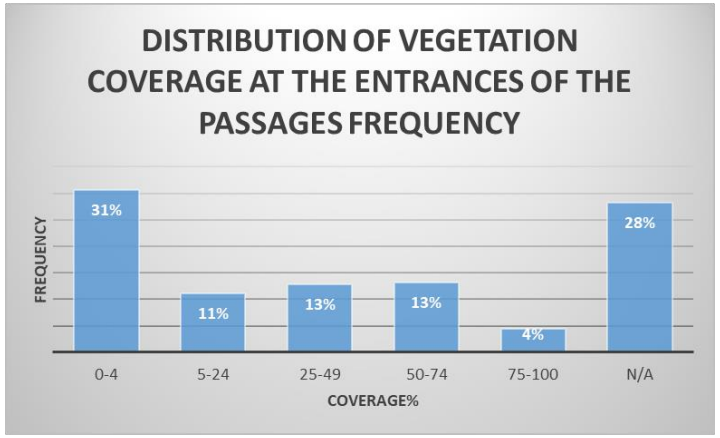


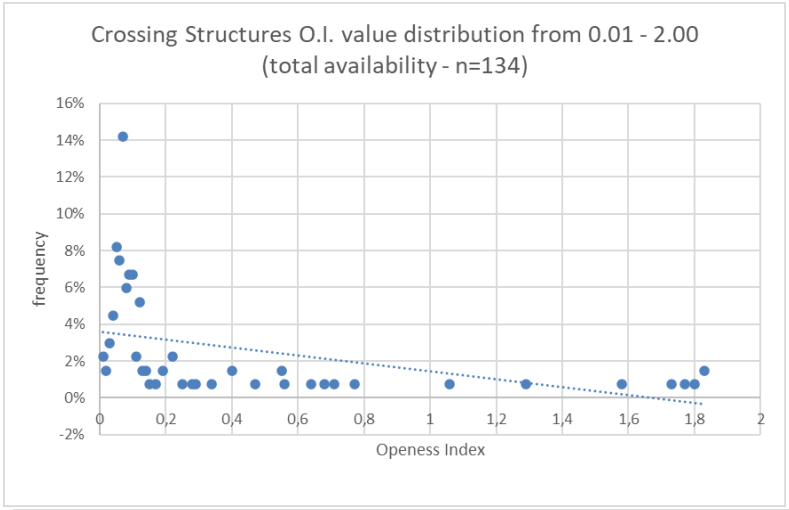
Map 2: distribution of all the crossing structures along highway A29. The symbols (pins) interpretation is as follows: (**a) yellow pins**: distribution of all (149) inspected crossing structures along highway A29– **(b) green pins+ red doted pins+ sun pins**: distribution of IR cameras monitored crossing structures (green pins : CS's used by bears, sun pins used by bears all 4 seasons) (c) red pins: additional CS's candidate for improvement (wht cameras).

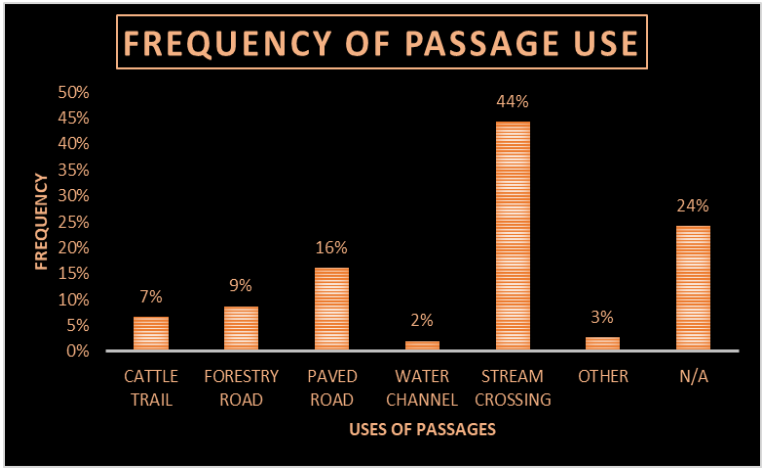
Results: CROSSING STRUCTURES/cameras monitoring data/brown bear/ CS's features

Sample representativity vs the main predictors: (a)CS veg.coverage at entrances, (b)Openness Index, (c)type of CS use

availability







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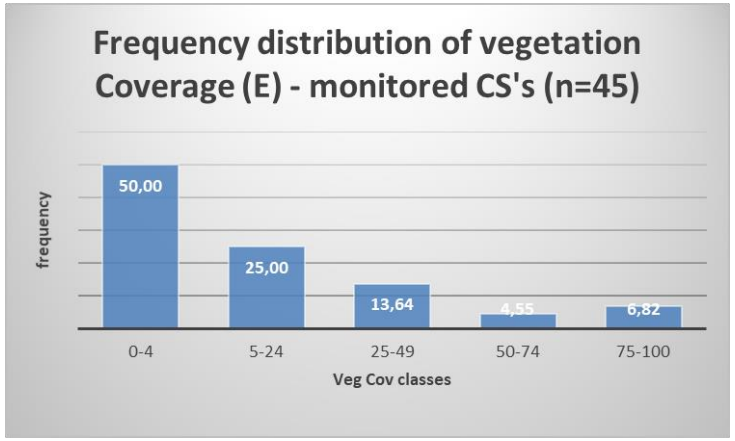
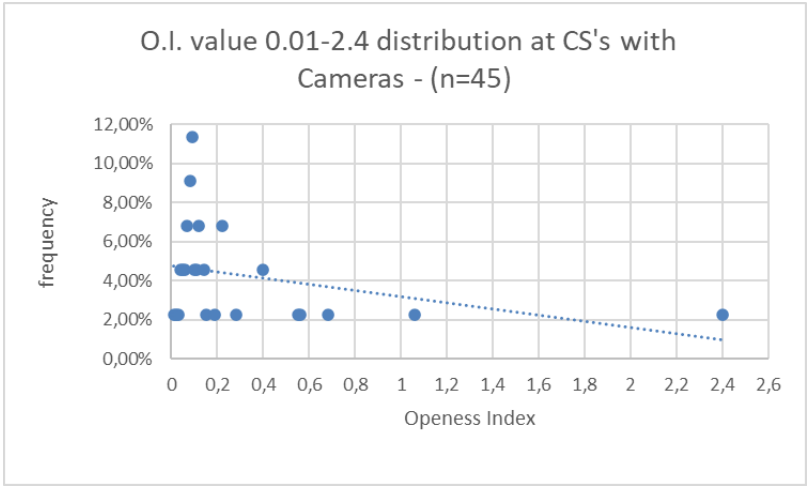
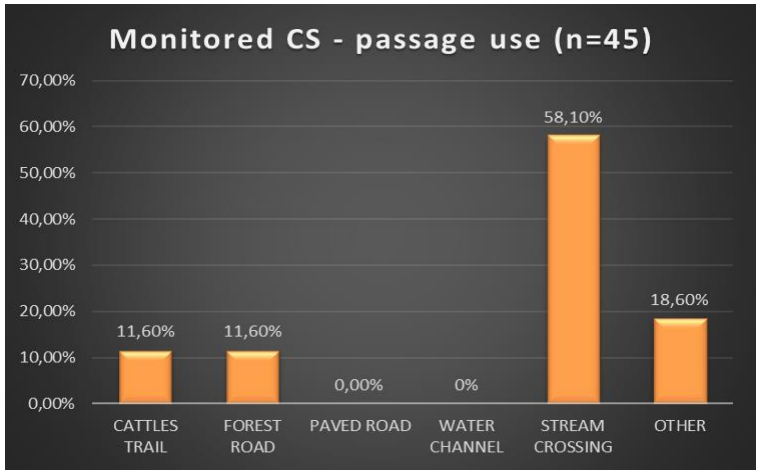
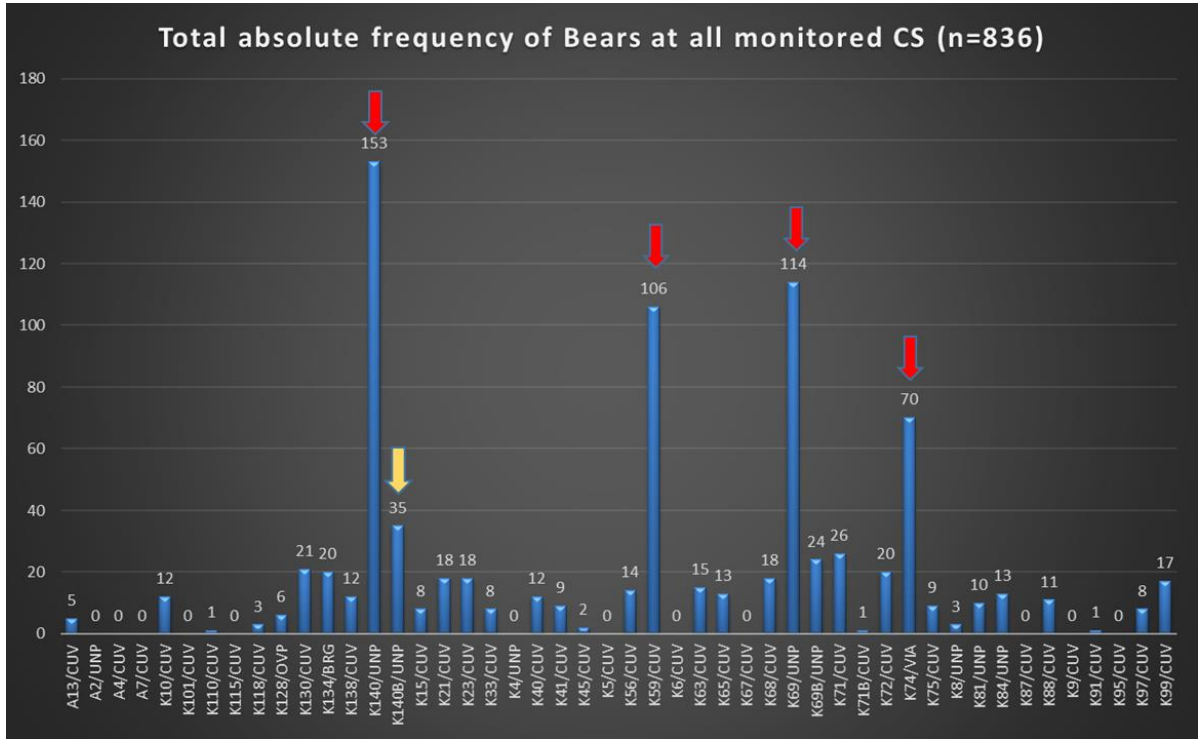


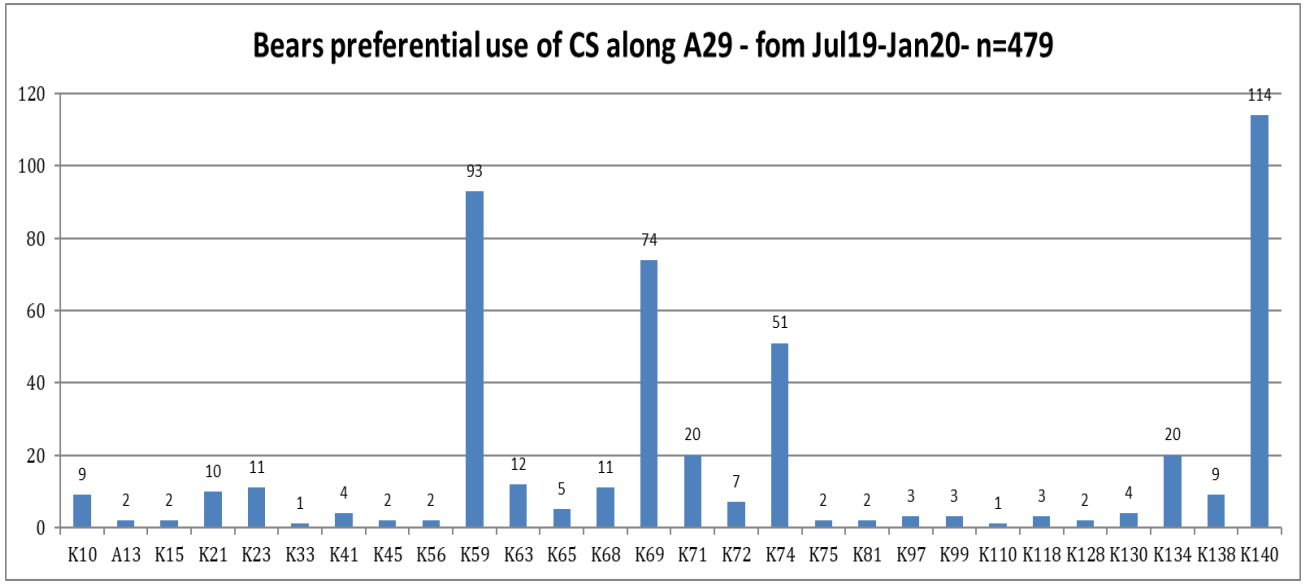


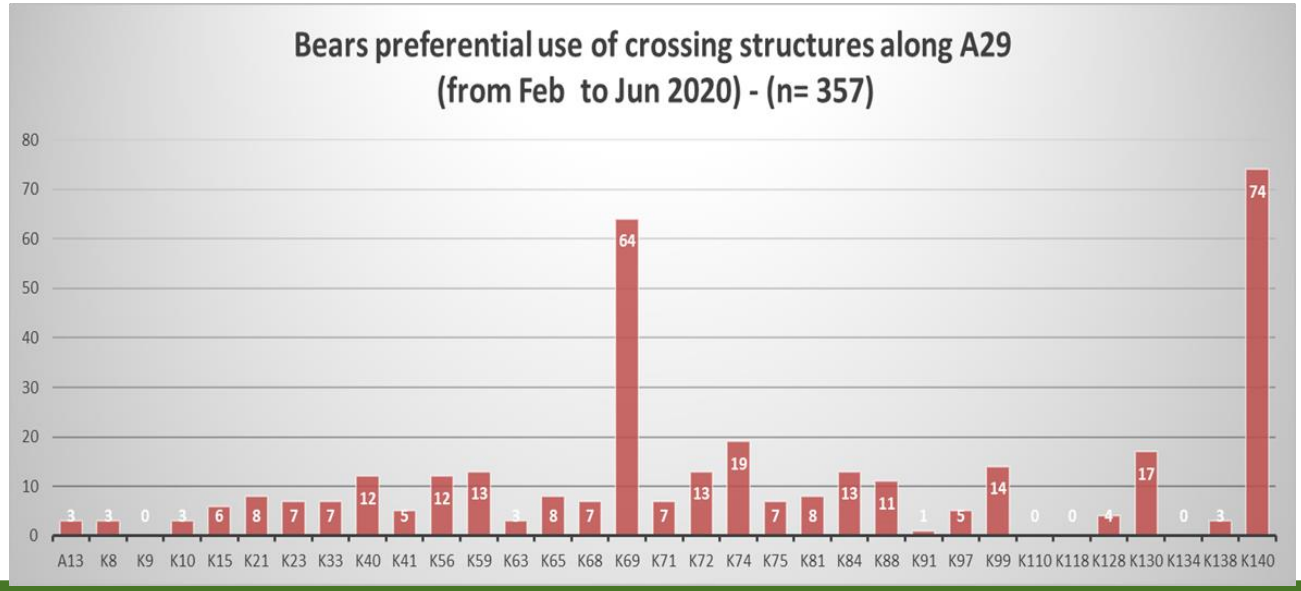


Results: CROSSING STRUCTURES/cameras monitoring data/brown bear vs CS's: overall

Periodic and overall use of monitored CS's by bears.







We did not detect any differences between the (2) monitoring periods in CS's use by bears, which could have been expected to be related to hypophagia and hyperphagia periods. (*V= 285, p-value = 0.943 , paired Mann-Whitney (Wilcoxon) rank test with continuity correction*)

Results: CROSSING STRUCTURES/bears/cameras monitoring data analyses

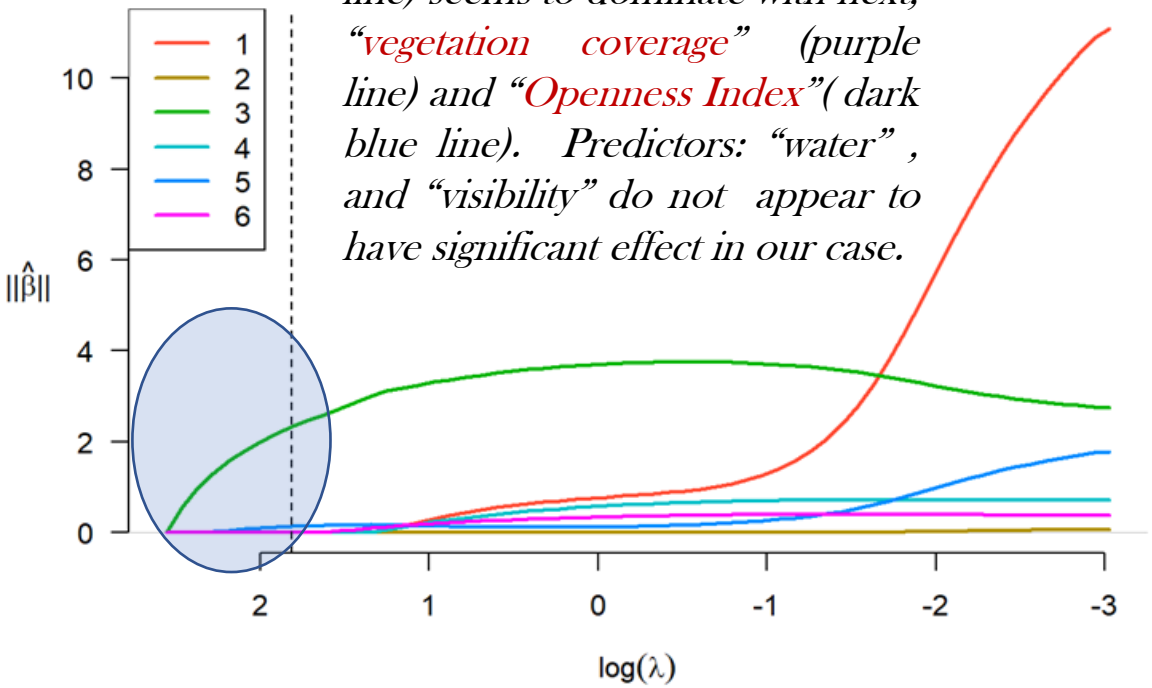
Do bears select CS's for their specific features? We used "R" to apply a **multivariate** analysis (using grouped **Lasso** (*least absolute shrinkage and selection operator) regression* tool). *"Lasso" regression analysis method performs both variable selection and regularization in order to enhance the prediction accuracy and interpretability of the resulting statistical model. In particular the "group Lasso" allows predefined groups of covariates to jointly be selected and tested.*

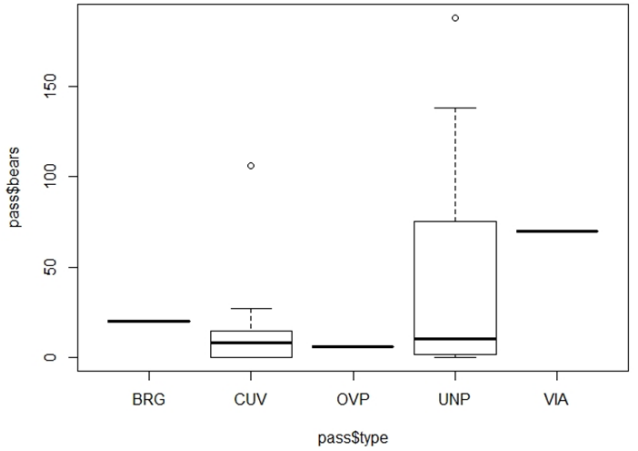
Created group of variables/predictors ***(covariates)***

(1),CS type (4)
(2) visibility
(3) CS use (3)
(4) water
(5)Openness Index
(6)Vegetation coverage c entrances

(λ) value: 6.718662

The predictor "CS use" (green line) seems to dominate with next, "vegetation coverage" (purple line) and "Openness Index"(dark blue line). Predictors: "water" , and "visibility" do not appear to have significant effect in our case.



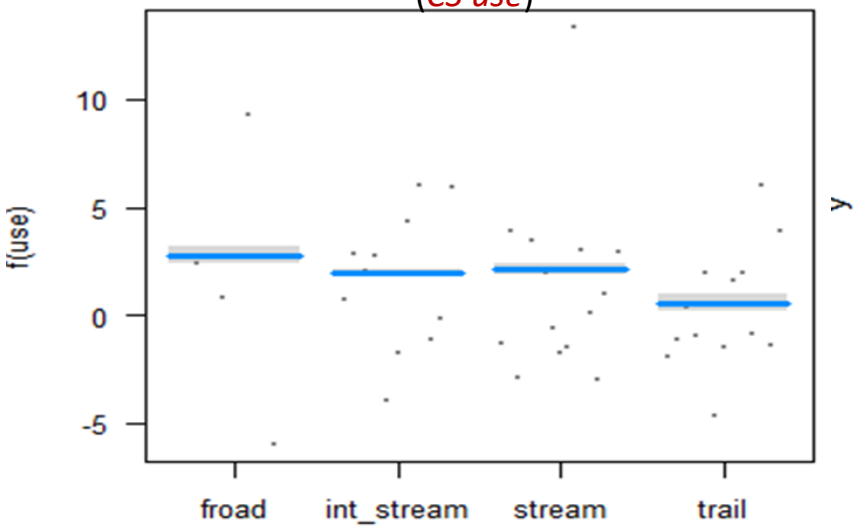


In our case, bears preferential use of CS type "**UNDP**"("underpasses") vs **CUV** (culverts)= ***non significant*** (***Kruskal-Wallis chi-squared = 4.1137, df = 4, p-value = 0.3908***).

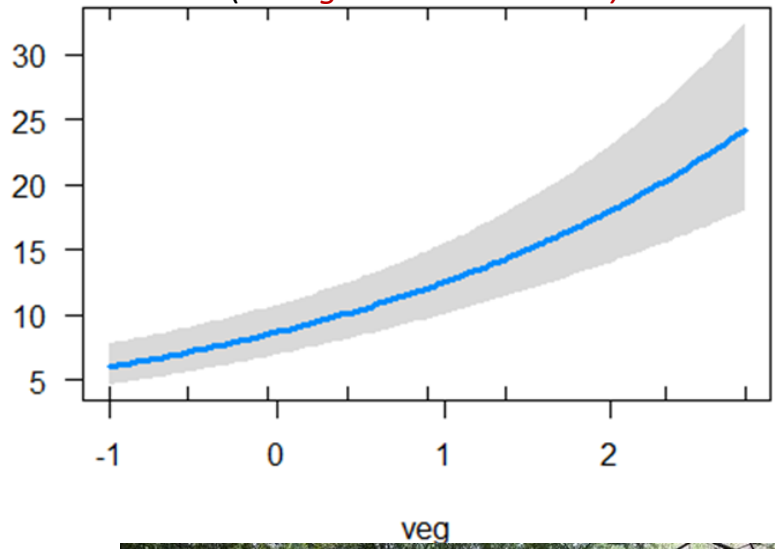
Results: CROSSING STRUCTURES/bears/cameras monitoring data analyses

Do bears select CS's for their specific features? The (3) graphs, better visualize the effect of each chosen predictor (covariate) to bear CS's selection. (*estimated number of bear events on the Y-axis, and the standardized covariate on the X-axis*).

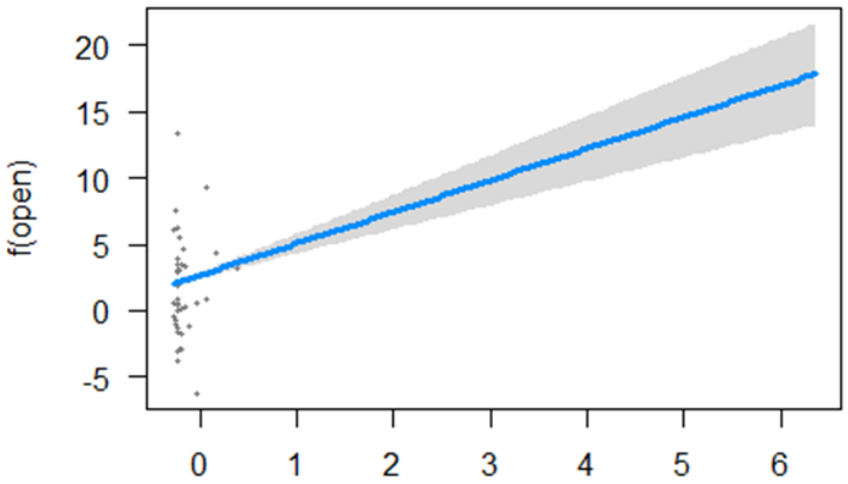
(*CS use*)



(*CS veg. cov. at entrances)*



(*CS Openness Index*)

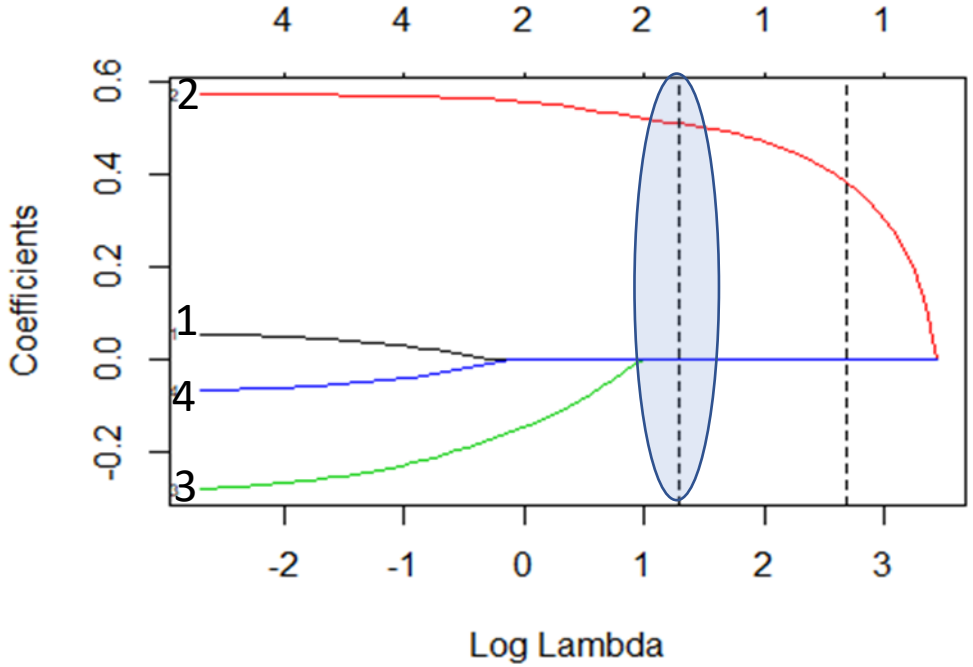


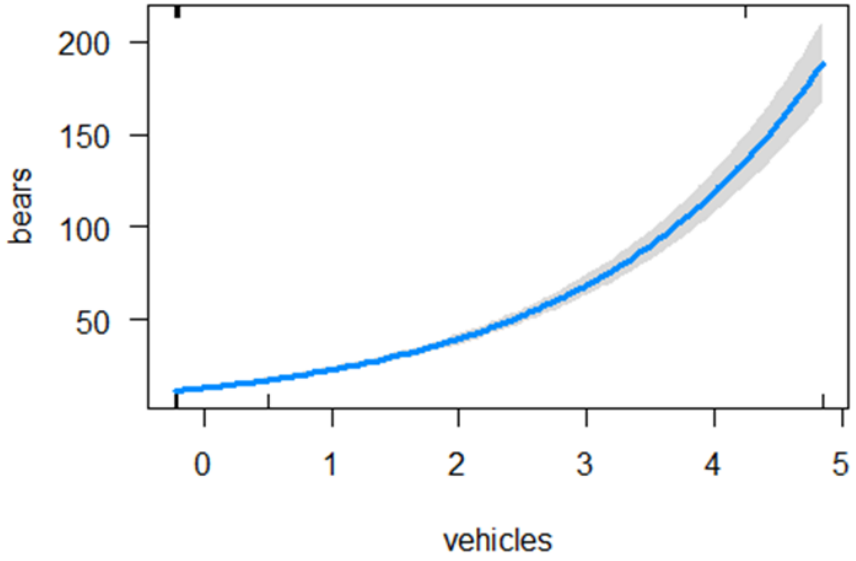
Results: CROSSING STRUCTURES/bears/cameras monitoring data analyses

How do bears react to certain wildlife crossing structures that are heavily used by humans?

We used "R" to apply again a grouped **Lasso** (*least absolute shrinkage and selection operator*) *regression* tool, to select predictors and to individualize the effect of the most influent predictor.

The response variable is "bear events" and the predictors/covariates are
(1) humans,
(2) vehicles,
(3) dogs,
(4) livestock





The predictor "*vehicles*" (2) (red line) effect on bears CS's preferential use seems to dominate (*decision threshold – left dashed line & coeff value*). Probably related to the fact that several larger CS's contain a forest road connecting larger habitat areas & human settlements and thus used by both bears (as long distance travelling LC's) and vehicles. The other covariates do not appear to have a significant effect probably because they are an integrated part of a humanized bear habitat/landscape to which bears seem to have adapted.

Results: CROSSING STRUCTURES/bears/adaptations – functional improvements

the main CS selection criteria for structural improvements were based on the significant effect of specific features :

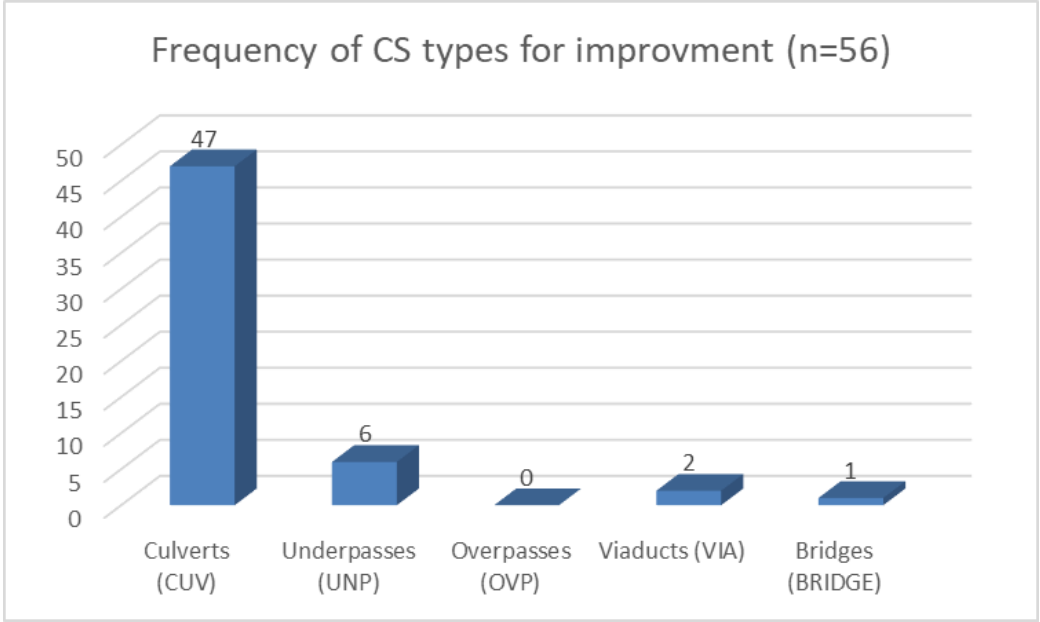
a) **The CS Openness Index** (OI) of **0.75** is critical as it is recommended as minimum for large size animals as bears according to the Guidelines to adapt transversal structures and increase their use by large carnivores and other wildlife (*LIFE SAFE-CROSSING, Minuartia 2020*). In (*Vaclav et al 2019*) the OI of 0.75 is recommended as minimal for medium sized mammals (roe deer, wild boar) while for large mammals as red deer and large carnivores the recommended minimum O.I. is **1.5**
b) surrounding environment **-----> CS vegetation coverage at entrances**
c) **The category of CS use.**

Additional criteria

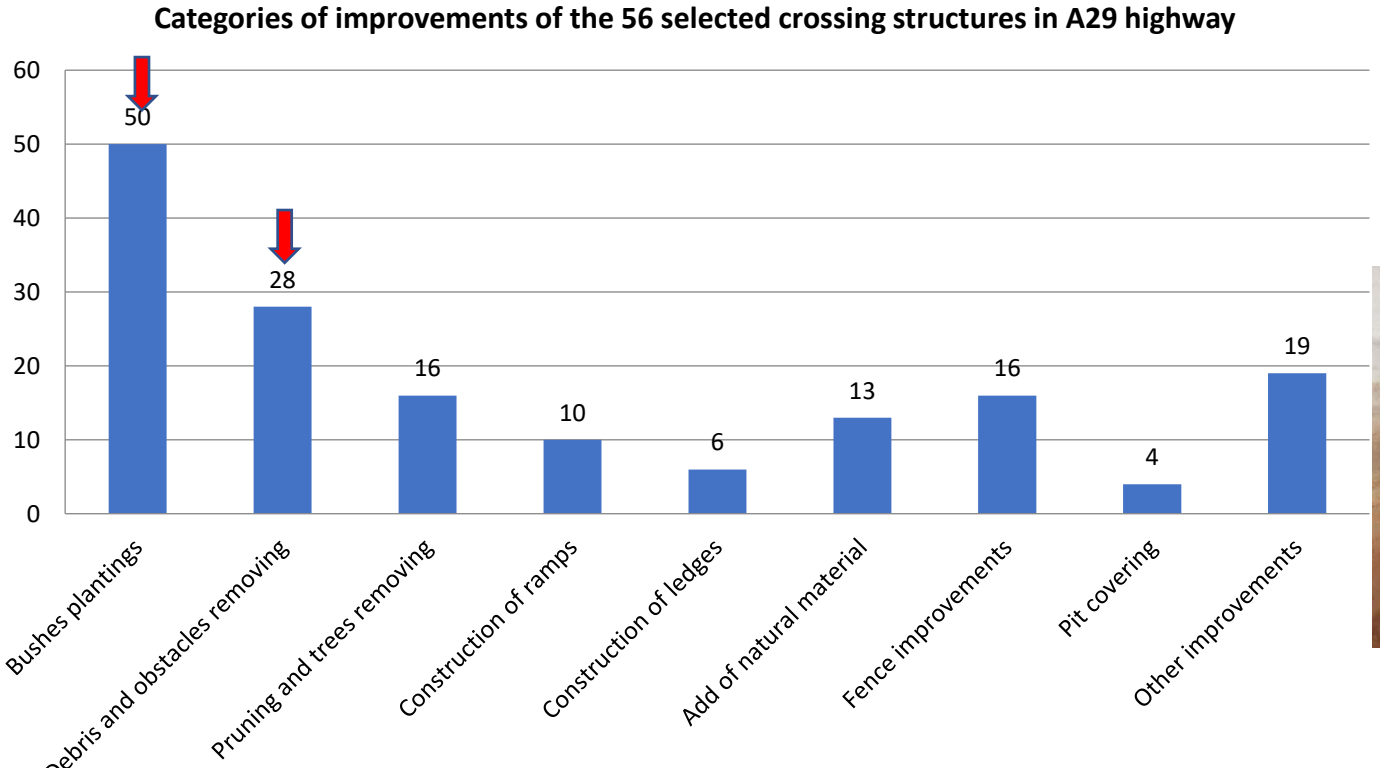
a. **Structures with the high level of use (more than 100 crossing) were not selected for improvement assumed as effective (Minuartia 2020))**

b. **Limited use by the bears but estimated as critical for connectivity issues**

c. **Possible use without confirmation by the cameras' data and based on the expert opinion and field data**



Results: CROSSING STRUCTURES/bears/adaptations – functional improvements



In total (**56)** CS have been selected to be improved. Bush plantations and removal of debris are directly related to the improvement of the CS features (*vegetation coverage & O.I.)* with the strongest effect on bears choice for use. Additional categories of technical interventions for CS's improvements include: a) construction of ramps and ledges, b) fence improvements, c) covering of pits

Conclusions

- The wildlife monitoring solution developed by COSMOTE's R&D Department was **a very innovative solution, developed from scratch specifically for the project monitoring needs (71.695 snapshots and videos processing).**
- **It appears that CS passage use, Openness Index and vegetation coverage are among the more influent factors (attributes) in bears preferential use**
- **It appears that vehicles use of CS's does not have a deterring effect to bears as they are adapted in using forest roads as less energy consuming routes in their movement patterns which are also used by vehicles.**
- **The above outcome was used to finalize the criteria for final selection of (56) CS's used by the target species *Ursus arctos** for improvement of their attractiveness and functionality.**

Questions (for Thematic group "Monitoring").

- i) How do we handle the mass of data input cost-effectively?
- ii) How do we overcome the lack of network coverage in underpasses?
- iii) How do we avoid vandalism/theft?
- iv) What about GDPR issues related to monitored CS's also used by humans?
- v) What would be an appropriate plan (sampling protocol) for monitoring 140 underpasses using 45 cameras?
- vi) Is monitoring necessary both before and after adaptations?
- vii) how important/contextual are CS features for bear use and adaptations?

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!!Thank you for your attention!!