



**LIFE
DINALP
BEAR**

Population level management and
conservation of brown bears in northern
Dinaric Mountains and the Alps



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EXPANSION OF BEARS FROM DINARIC MOUNTAINS INTO SOUTH-EASTERN ALPS REPORT

Action C.5: Population surveillance

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2. Introduction

An interesting and challenging feature of our project area is that it lies at the meeting of two large European biogeographic regions: Dinaric Mountains and the Alps. While Dinaric Mountains kept their population of brown bears as one of the largest indigenous bear populations in Europe, bears in the Alps went extinct, and were only brought back through the Trentino reintroduction in the late 1990s. However, bears have been sporadically appearing in the pre-Alpine and Alpine areas of western Slovenia and are gradually expanding from the “core” bear range in the Dinaric Mountains towards the west.

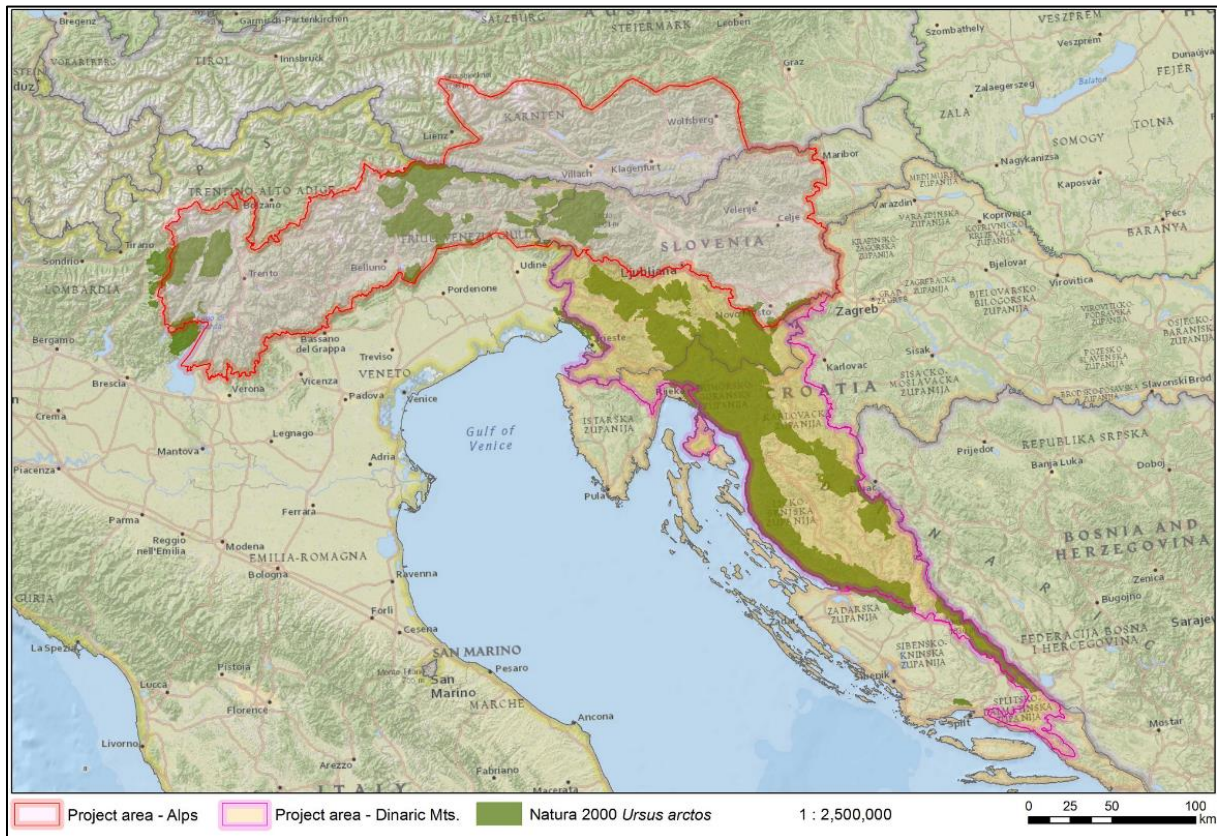


Figure 1: Core bear range in the Dinaric Mountains, and the “expansion zone” towards the Alps.

There seems to be an important barrier to this expansion: the Ljubljana – Koper highway, which separates the Dinaric bear range in Slovenia from pre-Alpine and Alpine areas. While the highway is not impassable for bears and the Dinaric area west of the highway is considered core bear range, it forms a considerable barrier. It was shown in a 2007 study using noninvasive genetic sampling that the population west of the highway was small and consisted mostly of males (70% males) – quite differently from the core bear range where approximately 60% of animals are females.

Since bears have been mostly absent from the Alps for generations, the local inhabitants there are not used to living with bears. Consequently, as the bears are reclaiming their historic range, they also cause conflicts disproportionate to their numbers. To tackle the challenges of the bear expansion into the Alps, we need to understand and monitor the process.

The goal of this study was to explore how the population is expanding towards the Alps. Firstly, we intensively sampled the pre-Alpine areas of bear core range in Slovenia, west of the Ljubljana – Koper highway, to see if the population there increased since the last survey done in 2007 (Skrbinšek, Jelenčič, Potočnik, Trontelj, & Kos, 2008). Following that, we opportunistically sampled in the Alps until 2018 to closely follow the developing situation there. We also sampled in the eastern part of the “expansion zone”, where bears have also been expanding their range.

3. Landscape features and description

The connection between Dinaric Mountains and the Alps lies entirely within Slovenia where these two major European bioregions meet. While historically bears never went extinct in the Dinaric Mountains, they disappeared from most of the Alps, and were only in the end of 1990s successfully reintroduced to Trentino region in Italy. While occasional bears have always been dispersing from Dinaric Mountains into SE Alps, the actual expansion of the reproductive population with females and cubs has been very slow. The core Dinaric-Pindos population hits a major barrier in its expansion towards west when reaching the Ljubljana – Koper highway (Figure 2). While bears have been present west of the highway for a long time (Jerina, Debeljak, Dzeroski, Kobler, & Adamic, 2003), the population density in that area has been considerably lower than in the east (Skrbinšek et al., 2019). However, this “Core Area West” (CAW) connects directly to SE Alps and is critical for natural recolonization of the Alps by bears (Figure 2).

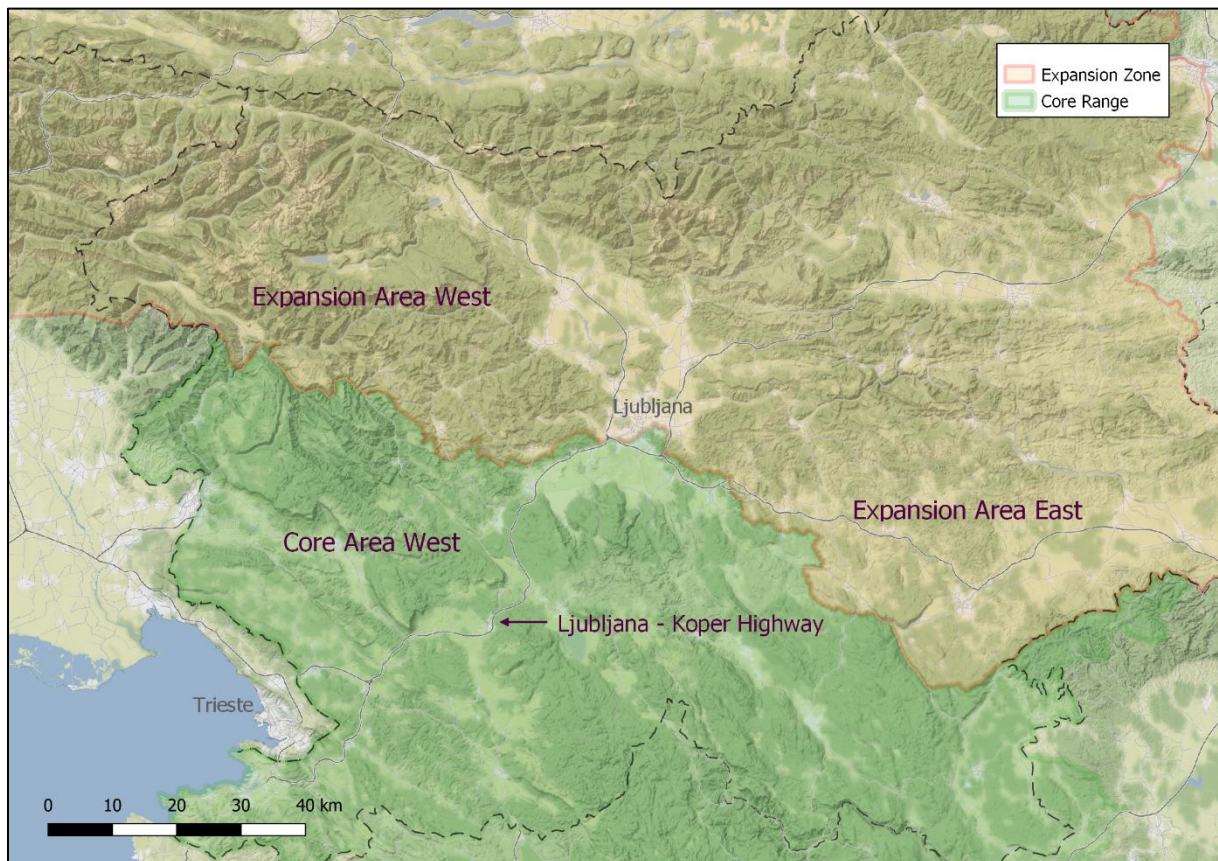


Figure 2: Connection between Dinaric Mountains and the Alps. The highest bear densities are in the Core range east of the Ljubljana – Koper highway. While bears are permanently present and reproducing also in the Core Area West, population density is much lower.

CAW connects directly to Expansion Area West (EAW) with no major physical barriers as the landscape changes from Dinaric into Alpine.

The large urbanized and agricultural areas of Ljubljana valley form a considerable barrier for bears in central Slovenia, and separate CAW and EAW from another possible expansion corridor, Expansion Area East (EAE). In this area the bear habitat is much more fragmented than towards west, with a dense mosaic of forest, human settlements and agriculture, and crossed by two major highways (Ljubljana – Zagreb and Ljubljana – Maribor) and Sava river. The area is less hospitable to bears than CAW and EAW, and more difficult to cross. However, bears have been expanding also using this route.

4. Methods

The core genetic and mark-recapture methods are the same as we used throughout LIFE DINALP BEAR, and are described in (Skrbinšek et al., 2017b). While sampling in the core bear range was mainly done through the intensive noninvasive sampling in 2015, we collected samples in the expansion area opportunistically until 2018.

As a comparison we're also using the study done in 2007 where bears were intensively sampled throughout their permanent range in Slovenia. The study is described in detail in (Skrbinšek et al., 2019) and (Skrbinšek et al., 2008).

For opportunistic sampling in EAW, we asked for help local hunters. In 2016 we organized meetings with representatives of hunting clubs, and distributed sampling material. The flasks with samples were returned to the laboratory with regular post, similar to the intensive sampling in the core bear range in 2015, as described in (Skrbinšek et al., 2017a).

5. Intensive sampling west of Ljubljana – Koper highway in 2015 and comparison with the situation in 2007

The intensive noninvasive genetic sampling in 2015 was done as a part of the large Slovenia – Croatia population abundance estimate (Skrbinšek et al., 2017b). The field methodology matched closely the sampling done in 2007 (Skrbinšek et al., 2008), making the results of both samplings comparable.

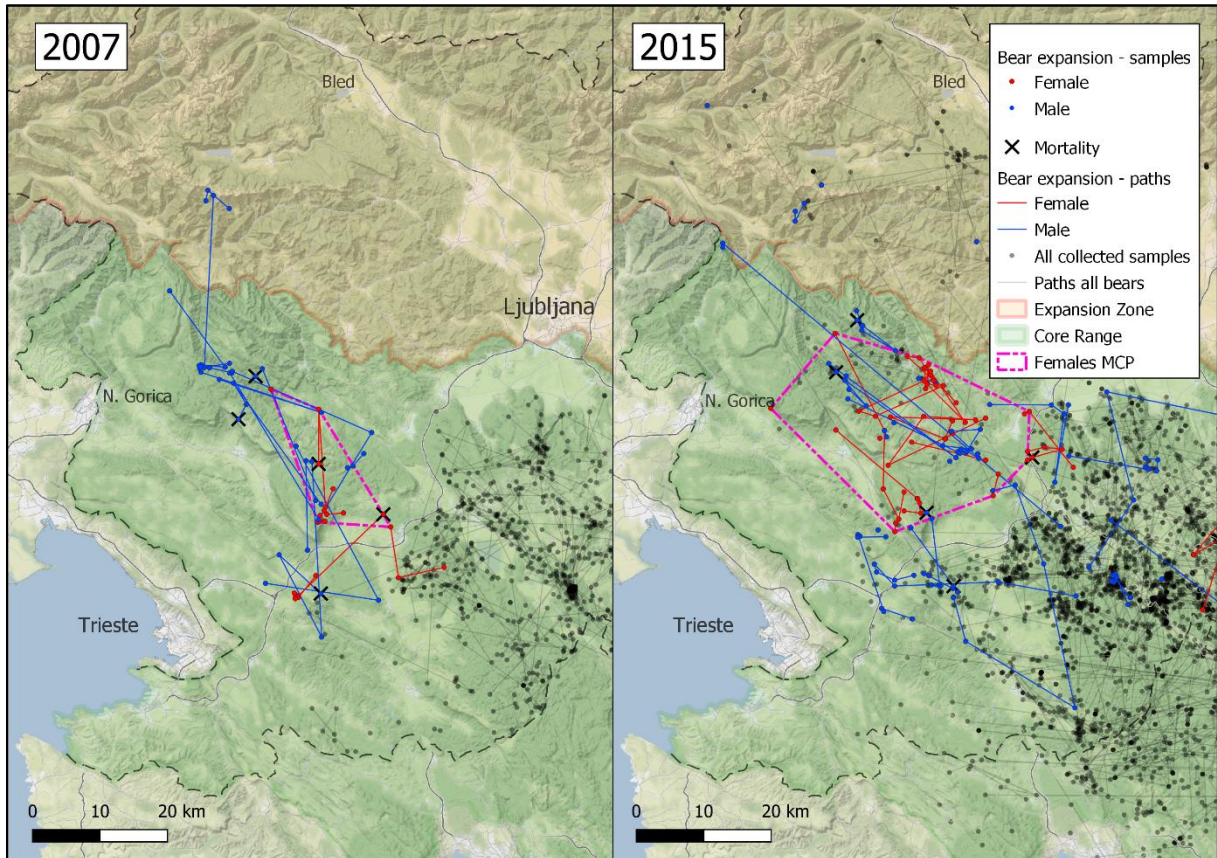


Figure 3: Core Area West, comparison of intensive sampling 2007 and 2015. Field methods and sampling intensity were approximately the same in both studies. The Females MCP is a minimum convex polygon of all female samples found in the area, and we can see that it is considerably larger in 2015, but still doesn't extend into the Alps to the north.

In the autumn 2015 sampling, we collected and successfully genotyped 129 noninvasive genetic samples collected in CAW west of Ljubljana – Koper highway (Figure 2). The samples were collected within 3 months. We did a mark-recapture model (Capwire TIRM, results with other models were very similar). Results and comparison with 2007 are summarized in Table 1.

Table 1: Comparison of results of noninvasive genetic sampling and mark-recapture population size estimates in Core Area West (west of Ljubljana – Koper highway) between 2007 and 2015.

Parameter	2007	2015
Population size estimate	21 (19-23)	48 (41-57)
Sex ratio Male Female	70% 30%	60% 40%
Detected males	12	24
Detected females	5	16
Total captured animals	17	40

While the population density in CAW was still considerably lower than in the core bear range to the east (Skrbinšek et al., 2017a), it more than doubled from 21 to 48 bears in the course of 8 years. During the same period the bear population in Slovenia increased by 41%, meaning that the population in this area with lower population density was growing faster than in the rest of the country. Even more importantly, the number of females tripled, making this a functioning part of the population, not just a dispersal area for males. However, the sex ratio still remains inverted since in the population east of the Ljubljana – Koper highway there are 59% females and 41% males (Skrbinšek et al., 2017a), a ratio that was nearly identical also in 2007 (Skrbinšek et al., 2008).

An important difference is also the range of females. While in 2007 the area of the minimum convex polygon of all female samples west of the highway is 150 km², in 2015 this is 675 km² (Figure 3). While this is a rough metric, it indicates a considerably wider range where the females were found. However, it also shows that the spatial expansion of the reproductive part of the population is relatively slow. Females in brown bear in general exhibit considerable philopatry (Zedrosser, Støen, Sæbø, & Swenson, 2007) and tend to remain close to their natal homerange. While the reproductive part of the population is expanding into the pre-Alpine areas, it seems that it didn't reach the Alps proper yet.

Ljubljana – Koper highway acts like an important linear barrier, but it is not impassable for bears. Even during the three months of the 2015 intensive sampling, we detected samples of 8 bears on both sides of the highway, however 7 of these were males. Moreover, several bears including females that were captured and GPS collared near this highway crossed it successfully (Jerina, Krofel, Stergar, & Videmšek, 2012). While the highway is a semi-permeable barrier for all bears, it may pose stronger barrier for females.

6. Intensive sampling in Expansion Area East (EAE) in 2015 and comparison with the situation in 2007

The eastern expansion area is first intersected by the Ljubljana – Zagreb highway, which represents the first major linear barrier to bear expansion in the area. However, the area around Novo mesto also has considerably more urban and agricultural areas than the core bear range to the south, presenting a “softer” barrier even before the highway.

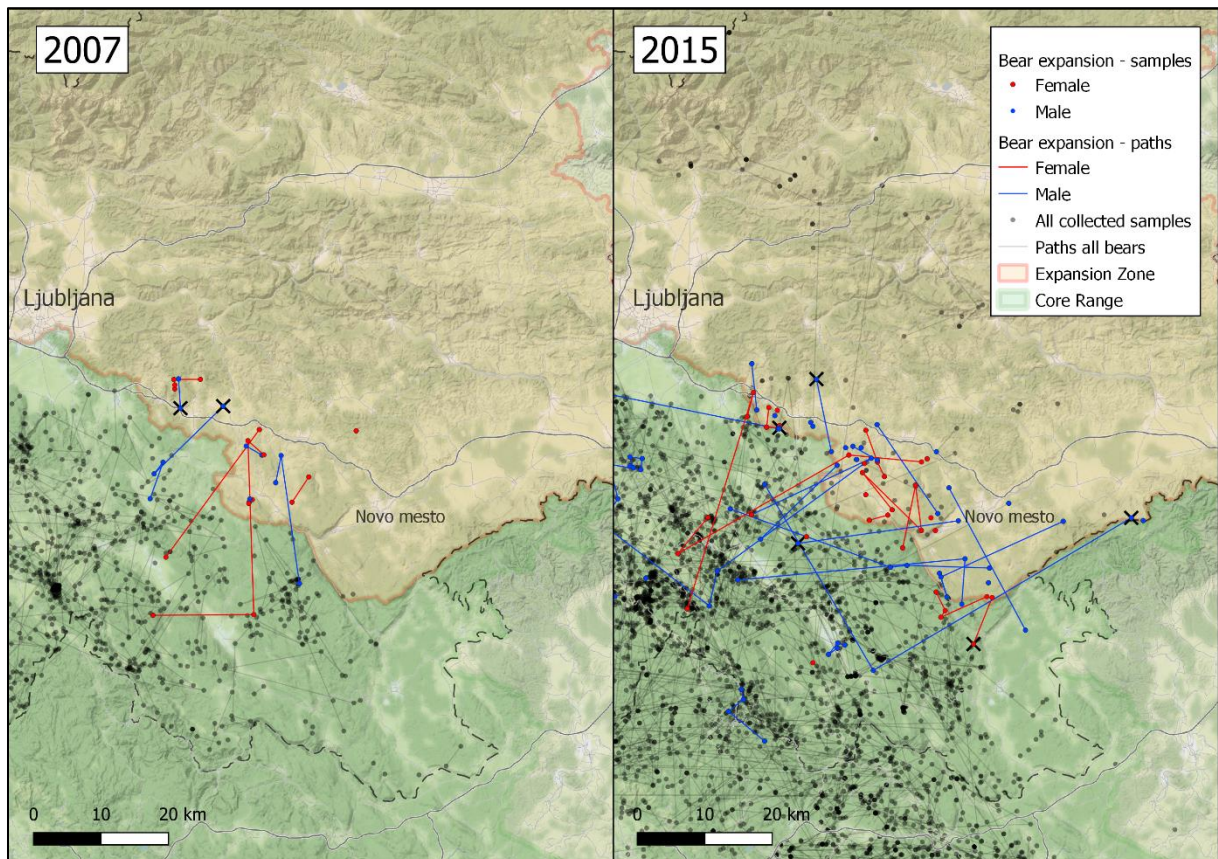


Figure 4: Expansion area east, comparison of intensive sampling 2007 and 2015. Field methods and sampling intensity were approximately the same in both studies. Intensive sampling was south of the Ljubljana – Zagreb highway (line north of Novo Mesto).

In the 2007 intensive sampling, we detected 12 bears in the area (5 M, 7 F). This number increased considerably in 2015, when we in the same area detected 40 bears (24 M, 16 F). Sex ratio is the same as in CAW, with 40% of females, and inverted than in the core bear range (Figure 4). However, only 4 males were detected in 2015 sampling north of the Ljubljana – Zagreb highway. On the other hand, in both samplings the focus was on the core bear range, and only opportunistic samples were collected north of the mentioned highway.

7. Opportunistic sampling in the expansion zone after 2015 intensive sampling

Between 2015 and 2018 we organized opportunistic sampling in the expansion zone to monitor the progress of brown bear population expansion. We collected and analysed 302 samples in the expansion zone and were able to successfully genotype 168 (Figure 5).

We detected 68 different animals, 45 males and 23 females. We recorded death of 27 (12F, 15M) of these animals, 21 in the expansion zone in the expansion zone (10F, 11M) and 6 (2F, 4M) in the core range.

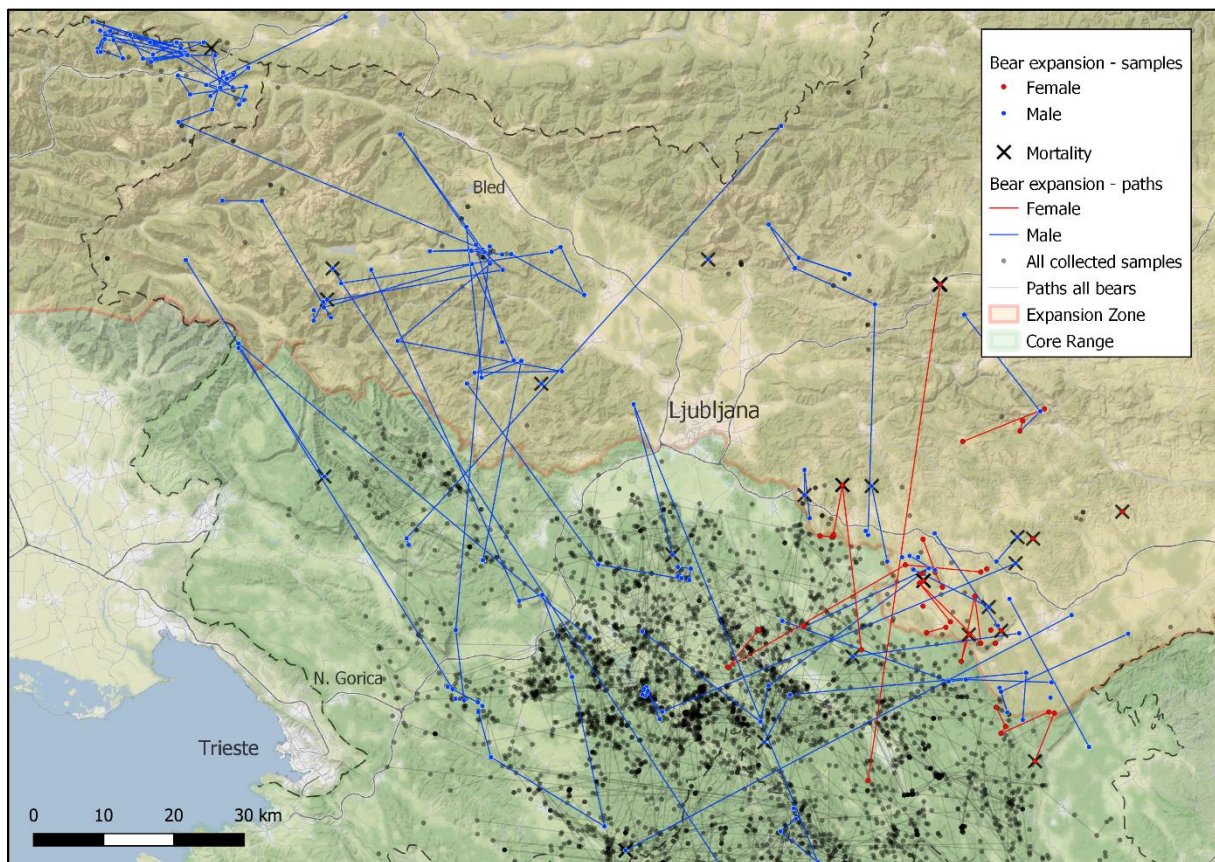


Figure 5: Opportunistic sampling 2015-2018 in the expansion zone. Samples of the animals detected in the expansion zone that were sampled in the core range are also shown.

There are considerable differences between the eastern and the western expansion area, and both areas will be treated separately in the continuation

7.1 Expansion zone east, opportunistic sampling

The southern part of the expansion zone east, south of Ljubljana – Zagreb highway, was sampled in the intensive sampling in 2015. The other areas within that zone were sampled opportunistically since bears there occur sporadically. Results are presented in Figure 6. Altogether we detected 47 animals, 24 males and 23 females. We detected mortality of 19 of these animals (11F, 8M).

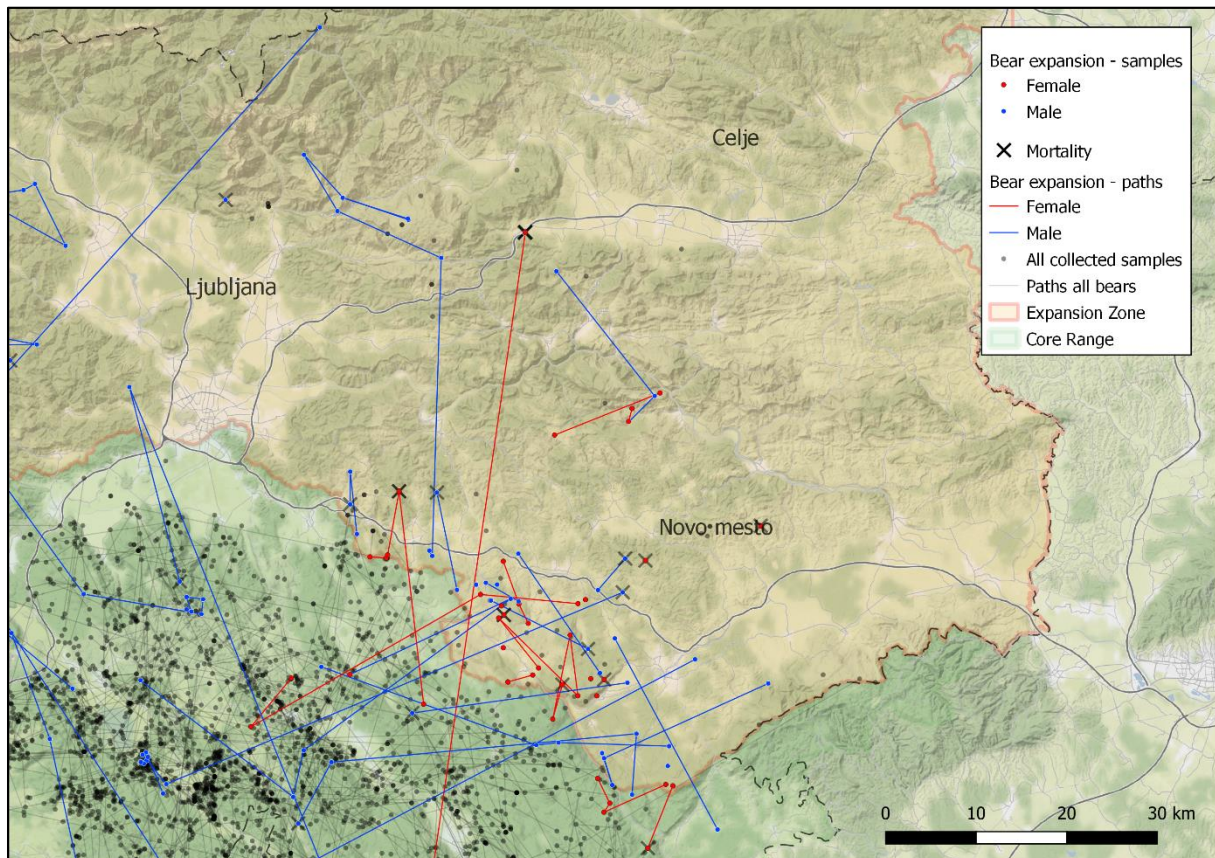


Figure 6: Opportunistic sampling 2015-2018 in the expansion zone east. Samples of the animals detected in the expansion zone that were sampled in the core range are also shown. Two major highways cross the area, Ljubljana – Zagreb (dark line close to Novo mesto) and Ljubljana – Maribor (close to Celje). One

In the southern part of this expansion zone, south of the highway, we detected 34 animals, 17 females and 17 males. Sex structure seems to be approaching that of the core bear range. However, north of the highway bears become rarer (16 bears sampled + 2 cubs of the year), but there is still a considerable number of females (6F, 10M). Two additional females were killed in a traffic accident as cubs of the year together with their mother at the Ljubljana – Maribor highway west of Celje (close to town Vransko).

7.2 Expansion zone west, opportunistic sampling

The western expansion zone are pre-Alpine and Alpine areas, where the lower, forest-covered Dinaric Mountains give way to the rocky, steep peaks of the Alps. The landscape becomes more rugged, with forested areas changing to alpine meadows at higher altitudes, and later into steep rock walls.

Characteristic of this area is that we didn't detect any females. We detected 18 males, and recorded mortality of 3 of them (Figure 7).

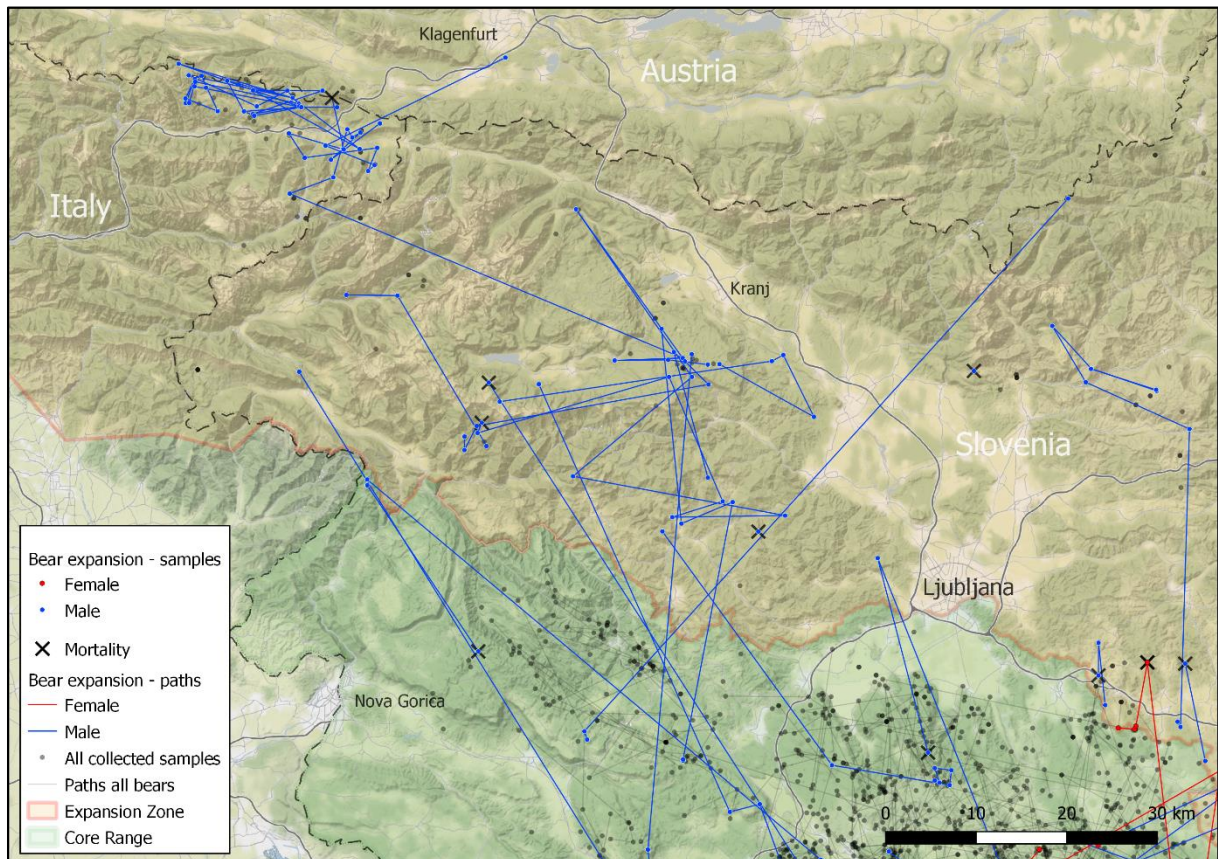


Figure 7: Expansion area west. Samples of the bears detected in EAW that were found outside of this area are also shown. Characteristic for this area is lack of females.

In the area we also detected three male bears that were sampled in previous samplings – two in 2007 and one as early as 2005 (Figure 8). This indicates that certain bears can exist also in the Alps for a long time (in this case 10 – 12 years) without causing enough conflict to warrant intervention culling or translocation. One of these bears was shot in March 2017 in an intervention cull for allegedly causing too much damage, although we didn't detect it in any of the samples from bear damages. It also had signs that it was wearing a telemetry collar although we couldn't determine yet which of the telemetry bears it was.

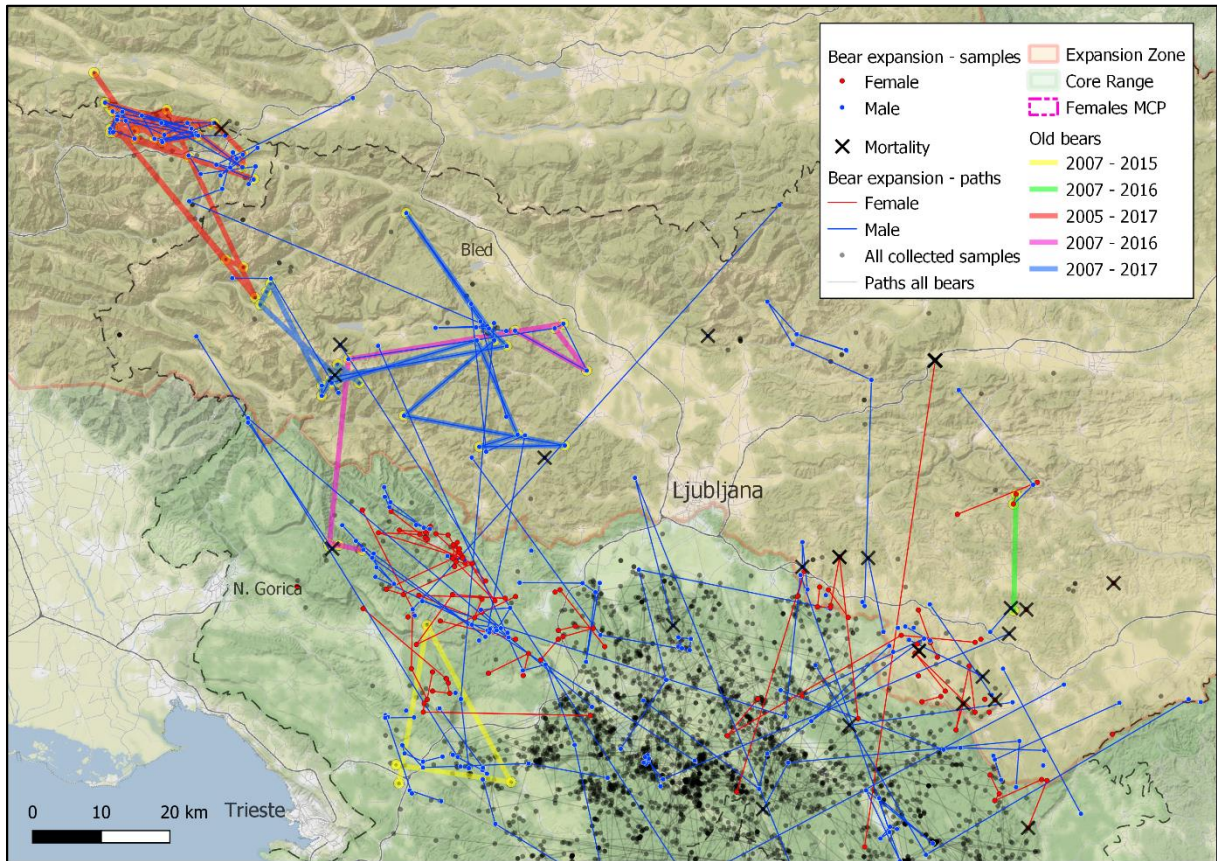


Figure 8: Bears detected in previous genetic samplings that were still alive in the expansion zone or CAW during LIFE DINALP BEAR.

Another male bear that we “knew” since 2007 was also detected in 2015 in core area west, but only a single sample. A female bear known since 2007 was detected in expansion area east.

8. Discussion

Expansion into the Alps is following two routes – the eastern and the western.

The eastern route lies east of the Ljubljana valley and the large agricultural and urban areas of central Slovenia. The southern part of this zone around Novo mesto and south of Ljubljana – Zagreb highway where only a few bears were detected in 2007 intensive sampling is now starting to look like the edge of the core bear range. In fact, this area south of Ljubljana – Zagreb probably shouldn't be considered expansion zone since the bear population there doesn't seem to differ much from the rest of the core bear range, but with the expected effects of being on the edge (lower population density, higher proportion of males). While the bear population density seems to drop sharply north of the Ljubljana – Zagreb highway, there are also female bears (some with cubs) detected in the north of the area. However, the landscape in these areas is much more fragmented than in the core bear range, and cut with important linear barriers (two highways, river Sava, see also (Rodriguez Recio et al., 2018)). While bears can and do move through, it is difficult to see a strong bear population developing in the area.

On the other hand, the landscape in the western route, once we cross the Ljubljana – Koper highway, seems to have less human-made obstacles and is less fragmented (Rodriguez Recio et al., 2018). It also connects into Italian Alps to the west, and through some anthropogenically changed landscape in the Sava river valley, also connects to Austria to the North. In the north, however, the landscape changes into a more rugged landscape of the Alps. While the bears have lived in the Alps before being nearly exterminated (Jerina & Adamič, 2008) and thrive in Trentino area in Italy where they've been reintroduced, these areas may seem less “attractive” to bears born in Dinaric forests. This, besides female philopatry (Zedrosser et al., 2007) and male-biased long distance dispersal (Jerina & Adamič, 2008), may be an explanation why females are so slow to expand into the Alps, and why we've so far found only males in the expansion area west. Still, considering the landscape characteristics (Rodriguez Recio et al., 2018) this route should probably be considered the main corridor for bears to naturally recolonize the Alps.

While we've seen a considerable increase in the brown bear population between 2007 and 2015 (and the population is probably still increasing (Jerina & Polaina, 2018)), the increase was even faster in the area west of the Ljubljana – Koper highway and around Novo mesto – the areas critical for bear expansion. Particularly the “core area west”, part of the core bear range west of Ljubljana – Koper highway, seems of a very high importance for expansion of bears into the Alps. The number of females detected in the area tripled since the 2007 sampling, and the area where females are found (as roughly estimated with a minimum convex polygon of locations of their samples) quadrupled, showing promise for a further expansion of the reproductive core of the population westward. But it must be noted that this expansion is almost certainly not going to be fast – while the males seem to be able to make long-distance dispersals into landscape that differs considerably from their natal range, this would seem to be a more challenging proposition for females.

All in all, the prospects for natural recolonization of south-eastern Alps by brown bears seem very good from the biological perspective. The population has been steadily expanding over the last decade – both with male dispersers as well as (more importantly) with its reproductive core of females. Given the will of the management authorities in Slovenia, Austria and Italy, adequate handling of conflicts with humans and high-enough tolerance of local residents, we should have a reproductive brown bear population in south-eastern Alps over the next couple of decades.

Unfortunately, the biological perspective is not the limiting factor in this equation. The bears have been functionally nearly absent from south-eastern Alps for over a century, and appeared there only sporadically. While the public attitudes survey we made in LIFE DINALP BEAR (Majić-Skrbinšek et al., 2016) indicates high public support for bear conservation in this area, support of general public and some interest groups (particularly livestock breeders) may drop rapidly as the number of bears increases. Bears are not always the easiest of neighbours, particularly in the areas where they've been absent for a long time. The work we did in LIFE DINALP BEAR is just the beginning, and considerable attention should be given to conflict resolution, public awareness and direct help to the interest groups most influenced by direct bear presence.

Of course, there is also the danger that Slovenian society would decide that bears are not desirable in Slovenian Alps and modify the management to that effect. This would completely stop a natural recolonization of the Alps from the Dinaric Mountains – while males would probably still regularly disperse into the Alps, this cannot be expected of females with any significant frequency, and the reproductive core of the population would invariably remain limited to Dinaric Mountains with occasional (but not permanent) dispersers into western Slovenian pre-Alpine areas. In this case Italy and Austria should consider translocations/reintroductions of females as possibly the only viable option for recolonization of their part of south-eastern Alps since the probability of a natural recolonization from Slovenia would be very slim.

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