Roads and fragmentation of wild reindeer habitat in Norway: consequences of the development of infrastructures for conservation

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Movement may be the most salient feature of the ecology of reindeer, as these group-living mammals are able to perform among the longest overland migrations in the world between summer and winter grazing areas. Before the industrial development Norwegian wild reindeer, *Rangifer tarandus tarandus*, were grouped into two-three large population units which performed extensive annual migrations over longer distances between adjacent mountain systems. Due to the development of roads, infrastructures and human disturbance, Norwegian reindeer are now divided into 23 more or less isolated populations. We studied the effect of a road dividing in two the annual range of one of these sub-populations on migration and movement patterns of reindeer. We used radio-tracking data of 10 individual female reindeer equipped with GPS collars between 2002 and 2010; one location/3 hours was recorded. We calculated trajectory parameters such as the Step Length SL, Turning Angles TA, and the Net Square Displacement NSD, and investigated variation in these parameters when reindeer approached and crossed the road. Reindeer did cross the road twice a year to migrate between the summer and the winter range, but trajectory analyses showed that the movement patterns were clearly affected by the presence of the road and of the human disturbance associated to it. In particular, when crossing the road the SL increased to reach the highest values recorded during the 45 days preceding or following the road cross. Similarly, the analysis of TA indicates that movements were significantly more directed during the crossing than in the preceding or following 45-day period. Finally, the analysis of NSD indicates that reindeer spatial behavior changed while the animals approached the road, and suggests that this obstacle delay the arrival to the traditional calving ground. Potential implications for conservation are discussed.