Estimating risk to prevent damage: proposals for management actions to prevent coypu damage to transport infrastructure

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The coypu (*Myocastor coypus*) is an invasive semi-aquatic rodent native to South America. Its negative impacts are mainly due to its digging activity in riverbanks and to the risk of floods and collapse damages to infrastructures. One of the riskiest situations concerns the collapse of roads or railways due to digging activities at intersections with watercourses. Preventive measures should be implemented to avoid collapse damages, but their implementation at all watercourses/transport infrastructures intersections is not economically viable. In this study, we propose the use of model-based analyses of species-habitat relationships to identify the characteristics of areas most susceptible to digging by coypu to guide the selection of priority areas where to develop specific preventive actions. This study was commissioned by the Italian Railway Network to the University of Milano-Bicocca to identify the most susceptible areas to digging by coypu along railway lines. To reach this aim we modeled species-habitat relationships at both landscape and local scale through i) a predictive model of species presence probability in the central area (17,000 km^2) of Lombardy (northern Italy), and (ii) detailed models to identify the environmental characteristics of the railway line-watercourse intersections (RLWIs) that make them particularly susceptible to digging. For the predictive model, we used a presence vs availability approach: coypu presence points (N=1804) were obtained from GBIF and Ornitho platforms (period: 2018-2022), while availability points (N=1804) were generated using a bias map (KD [Kernel density] 95% of presence points). Twenty-two environmental variables were calculated within buffers of different size around presence/availability points and a multi-scale ensemble model was developed to estimate the relationships between species presence probability and environmental variables. For the development of the detailed models, in spring 2022, we visited 61 RLWIs (within the KD50% of presence points) to detect coypu dens occurrence and collect environmental data. We then developed: i) a glm (presence [RLWIs with coypu dens: N=27] vs absence [RLWIs without coypu dens: N=34]) to assess the effect of environmental variables on the probability of coypu digging within a 50m buffer around RLWIs, and ii) a lm to assess the effect of environmental variables on the distance of dens (N=27) from the RLWI.

From the results of the ensemble model (AUC>0.9) we developed a predictive map of the potential distribution of coypu in the whole study area: coypu selected extensive agricultural areas characterized by developed hedgerows and watercourses networks close to rivers and/or marshes, while it avoided intensive agricultural areas with maize cultivation and both woodland and urban areas. The GLM (Explained deviance=43%) stressed that the RLWIs most susceptible to coypu digging were those surrounded by arable lands with interspersed hedgerows locally characterized by high herbaceous vegetation and silty-clayey soil. Conversely, RLWIs locally characterized by shrub vegetation and gravelly soil were significantly avoided. The lm (R^2=41%) showed that at RLWIs located in urban contexts with a poor hedgerow network locally characterized by high shrub cover coypu dens are excavated significantly closer to the railway increasing the risk of collapse damage. Our results provided practical indications to i) prioritize RLWIs where to implement preventive actions, considering both species presence probability at the landscape scale and environmental characteristics of RLWIs at the local scale, and ii) to design effective preventive actions. These actions can include both the installation of devices that discourage excavation (e.g., partially buried wire meshes) and environmental interventions that reduce the suitability for excavation close to the RLWI (e.g., mowing herbaceous vegetation) and increase suitability at a safe distance from the RLWI (e.g., maintaining high herbaceous vegetation).