

A detailed description of Figures S1–S4

The four machine learning models are support vector machine (SVM), k-nearest neighbor (KNN), random forest (RF) and extreme gradient boosting (XGBoost).

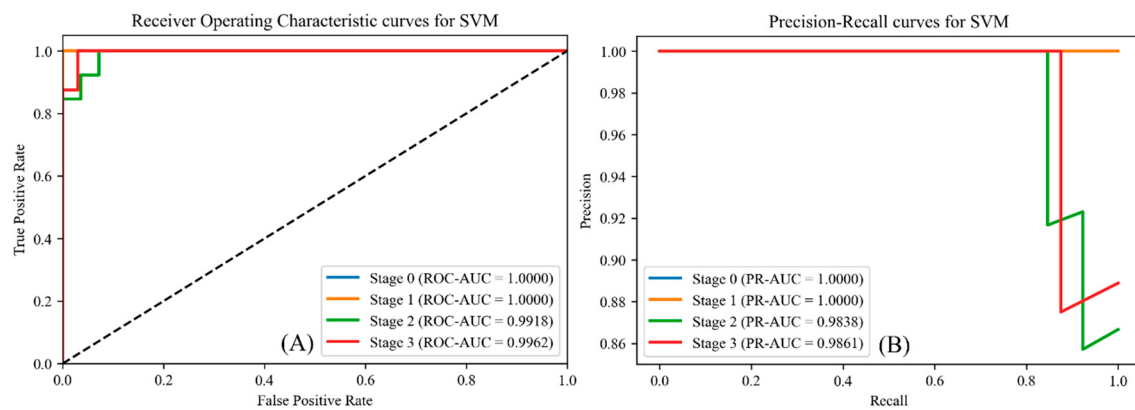


Figure S1. Precision-Recall (PR) and Receiver Operating Characteristic (ROC) Curves for the SVM Model at Different Stages. The figure displays PR and ROC curves for four stages, with the Area Under the Curve (AUC) values—specifically, ROC-AUC and PR-AUC—provided in the figure legend. The stages include: Stage 0, representing active patches; Stage 1, representing inactive patches; Stage 2, representing recovering patches; and Stage 3, representing healthy alpine meadow areas.

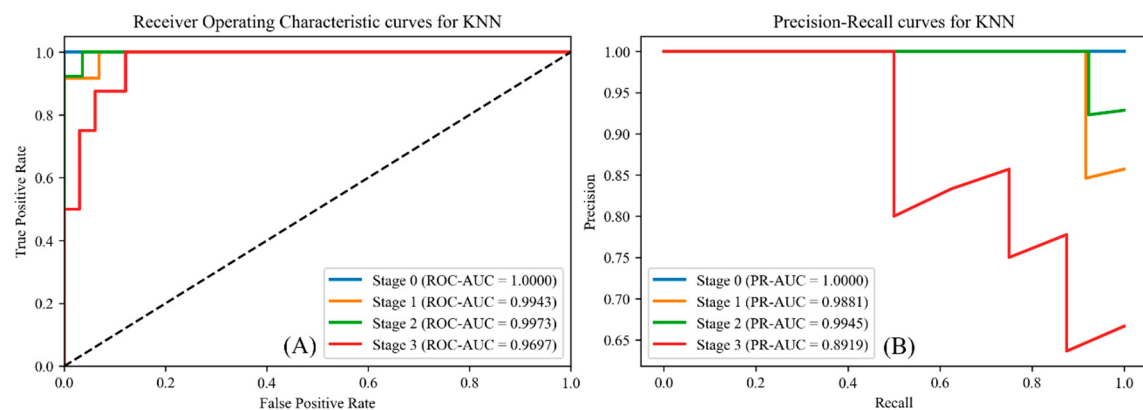


Figure S2. Precision-Recall (PR) and Receiver Operating Characteristic (ROC) Curves for the KNN Model at Different Stages. The figure displays PR and ROC curves for four stages, with the Area Under the Curve (AUC) values—specifically, ROC-AUC and PR-AUC—provided in the figure legend. The stages include: Stage 0, representing active patches; Stage 1, representing inactive patches; Stage 2, representing recovering patches; and Stage 3, representing healthy alpine meadow areas.

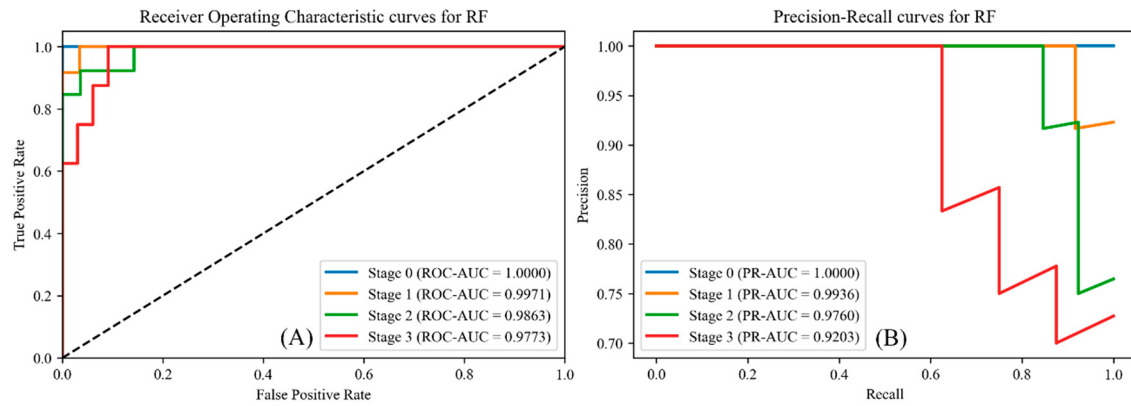


Figure S3. Precision-Recall (PR) and Receiver Operating Characteristic (ROC) Curves for the RF Model at Different Stages. The figure displays PR and ROC curves for four stages, with the Area Under the Curve (AUC) values—specifically, ROC-AUC and PR-AUC—provided in the figure legend. The stages include: Stage 0, representing active patches; Stage 1, representing inactive patches; Stage 2, representing recovering patches; and Stage 3, representing healthy alpine meadow areas.

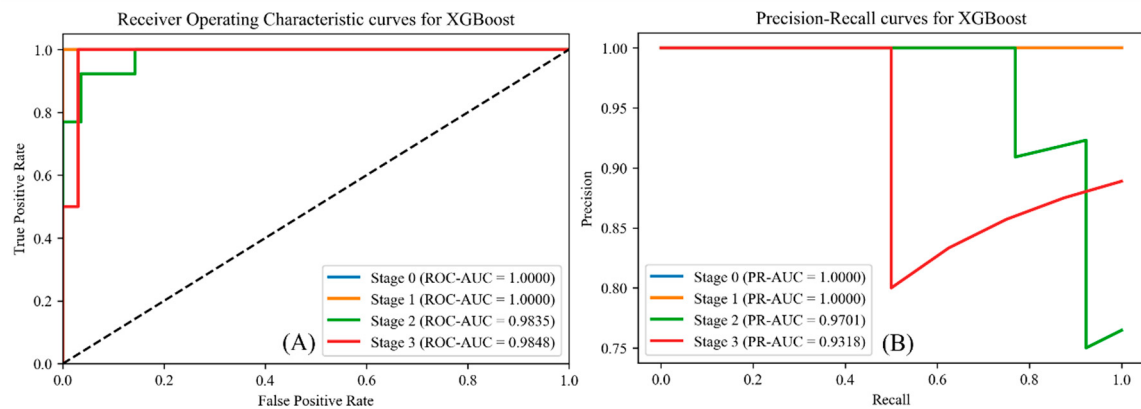


Figure S4. Precision-Recall (PR) and Receiver Operating Characteristic (ROC) Curves for the XGBoost Model at Different Stages. The figure displays PR and ROC curves for four stages, with the Area Under the Curve (AUC) values—specifically, ROC-AUC and PR-AUC—provided in the figure legend. The stages include: Stage 0, representing active patches; Stage 1, representing inactive patches; Stage 2, representing recovering patches; and Stage 3, representing healthy alpine meadow areas.