

Nguyen Thanh Tuan, Phan Van Tuan, Nguyen Thanh Hung, Duong Tien Duc
**Individual tree detection and crown segmentation for *Pinus kesiya*
using UAV–LiDAR and deep learning models**

Supplementary Material

Table S1. The performance of the three deep learning architectures (YOLOv8m, YOLOv11m, and YOLOv12m-Sam2) was evaluated using 5-fold cross-validation, followed by 999 bootstrap resamples

Model	Metric	Mean	CI_low	CI_high
YOLO8m	seg_mAP50	0.41	0.34	0.48
	seg_mAP50-95	0.16	0.12	0.20
	seg_precision	0.48	0.37	0.56
	seg_recall	0.42	0.37	0.48
	seg_F1-score	0.45	0.37	0.52
	box_mAP50	0.44	0.36	0.51
	box_mAP50-95	0.19	0.15	0.24
	box_precision	0.50	0.39	0.59
	box_recall	0.44	0.39	0.50
	box_F1-score	0.47	0.39	0.54
YOLO11m	seg_mAP50	0.60	0.57	0.62
	seg_mAP50-95	0.26	0.25	0.27
	seg_precision	0.59	0.57	0.60
	seg_recall	0.58	0.54	0.62
	seg_F1-score	0.59	0.56	0.61
	box_mAP50	0.62	0.59	0.64
	box_mAP50-95	0.29	0.29	0.29
	box_precision	0.59	0.56	0.62
	box_recall	0.62	0.60	0.64
	box_F1-score	0.61	0.58	0.63
YOLO12m-Sam2	seg_mAP50	0.60	0.55	0.64
	seg_mAP50-95	0.16	0.14	0.18
	seg_precision	0.60	0.55	0.64
	seg_recall	0.62	0.57	0.66
	seg_F1-score	0.61	0.56	0.65
	box_mAP50	0.61	0.59	0.63
	box_mAP50-95	0.29	0.28	0.30
	box_precision	0.60	0.56	0.63
	box_recall	0.61	0.58	0.63
	box_F1-score	0.61	0.57	0.63

Table S2. Accuracy assessment of tree crown segmentation by YOLOv11 model for the three forest plots

Sites	Mean IoU	Precision	Recall	F1	mAP50	mAP50–95
Plot 1 (720 trees/ha)	0.60	0.74	0.69	0.71	0.74	0.32
Plot 2 (320 trees/ha)	0.65	0.80	0.75	0.77	0.80	0.38
Plot 3 (500 trees/ha)	0.74	0.90	0.80	0.85	0.91	0.58

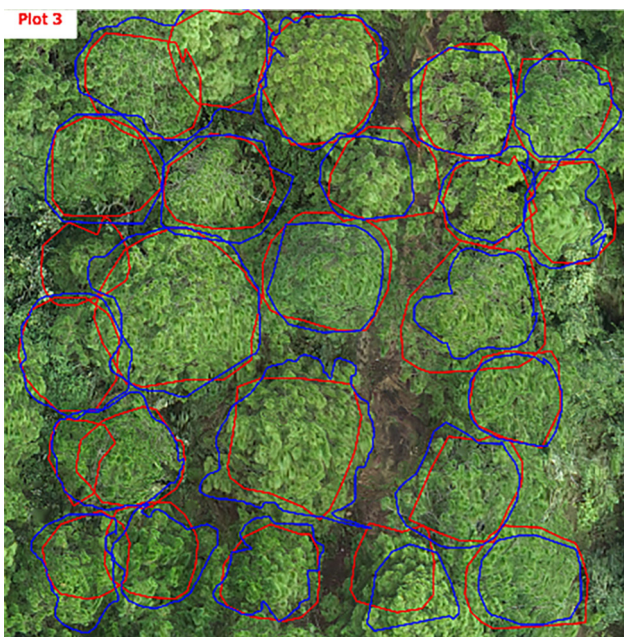
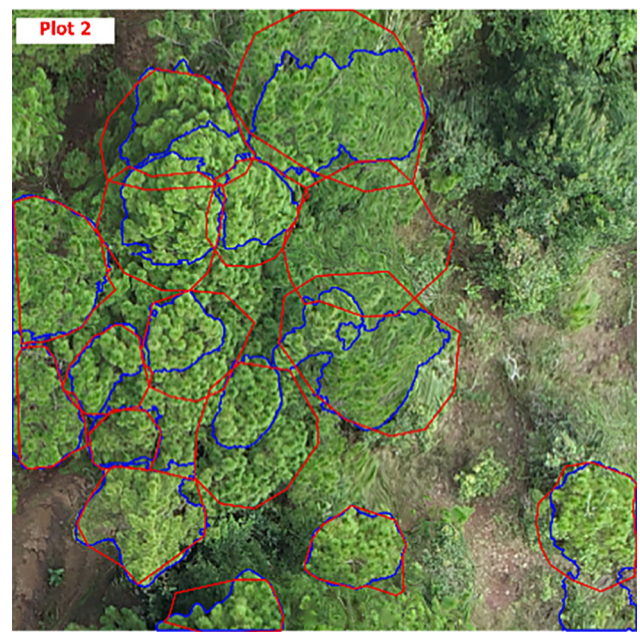
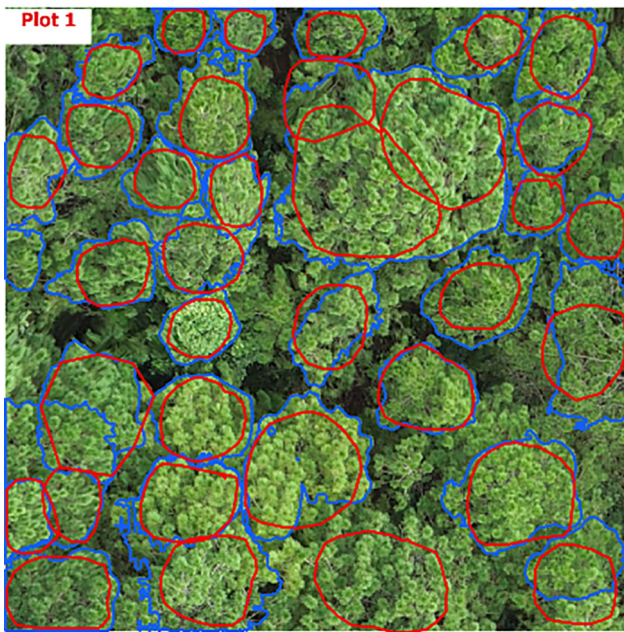


Fig. S1. Visualization of tree crown segmentation, showing YOLOv11 predictions in blue and reference crowns in red

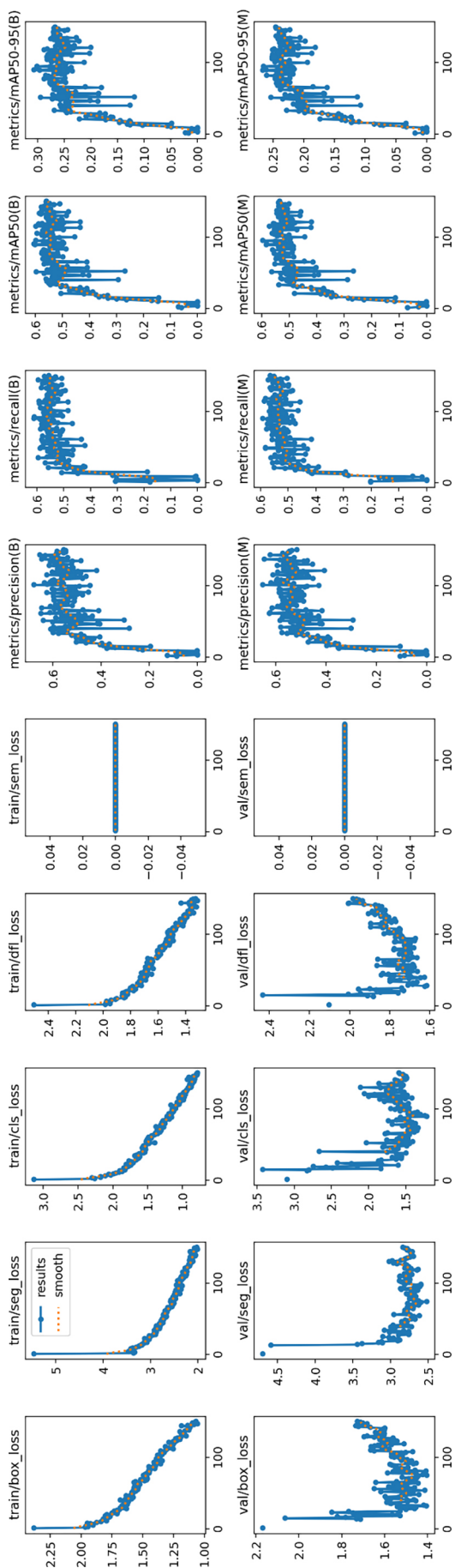


Fig. S2a. Training loss curves of the YOLOv11 model for fold 1

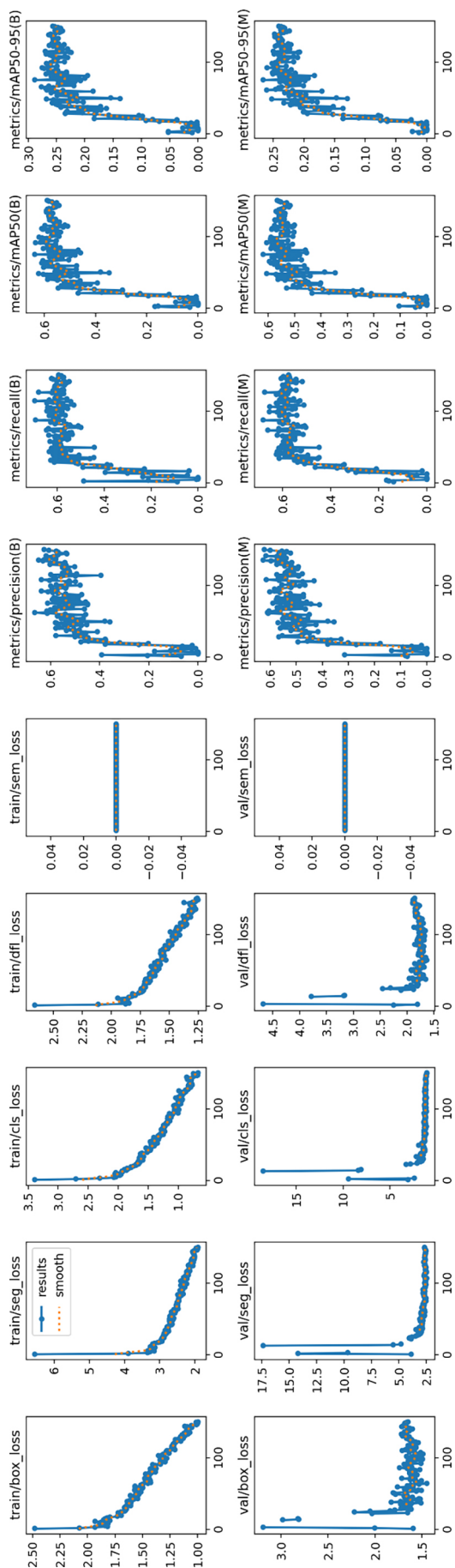


Fig. S2b. Training loss curves of the YOLOv11 model for fold 2

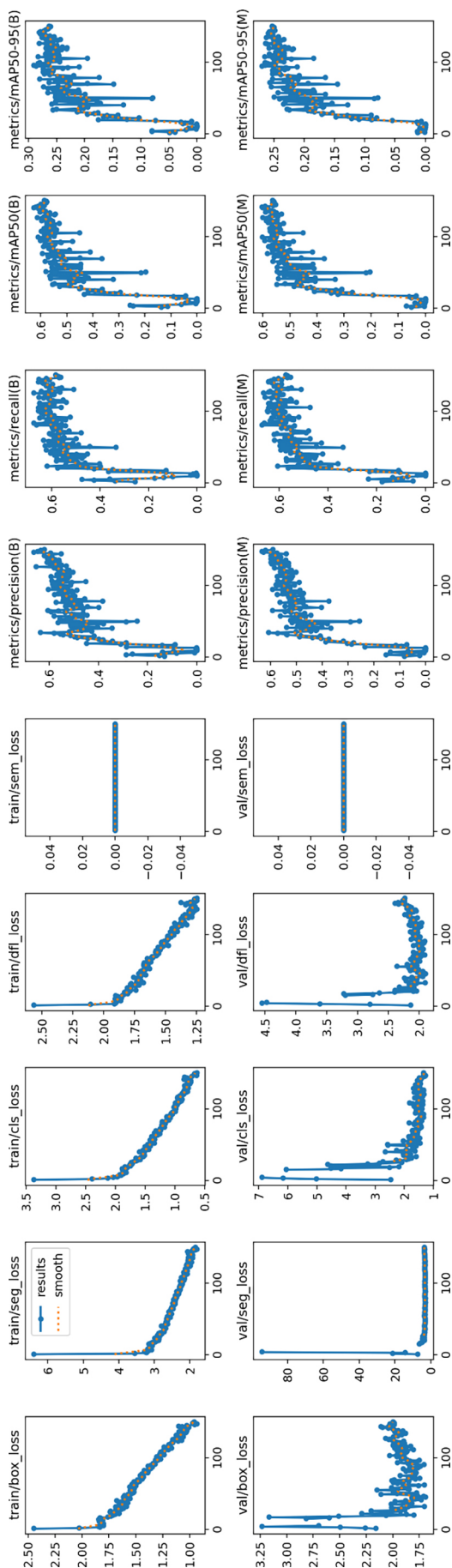


Fig. S2c. Training loss curves of the YOLOv11 model for fold 3

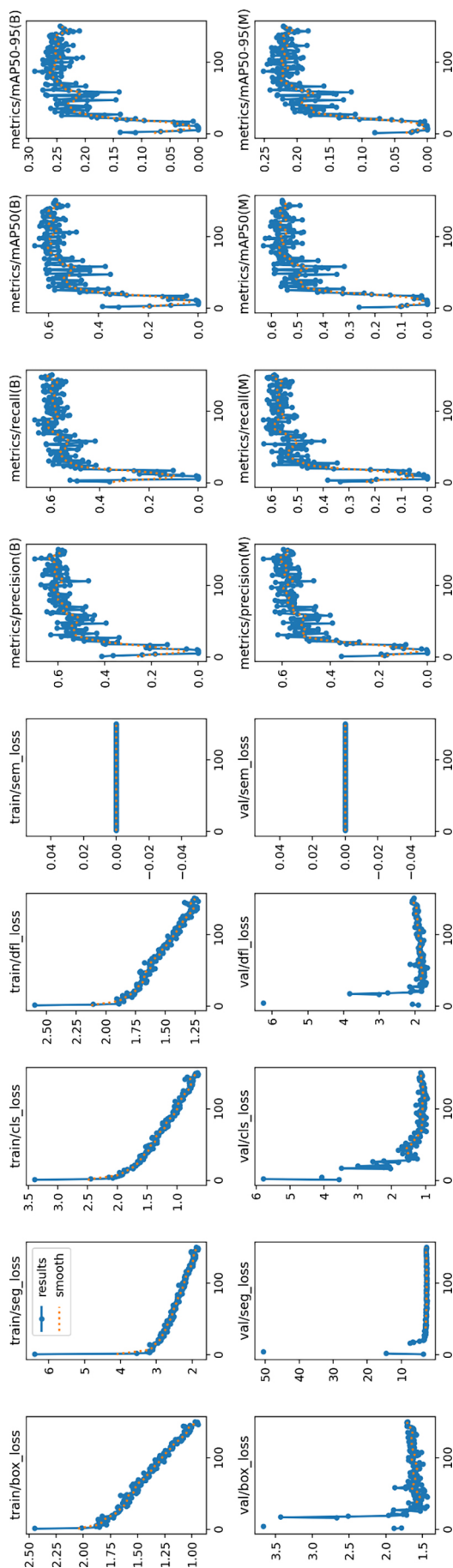


Fig. S2d. Training loss curves of the YOLOv11 model for fold 4

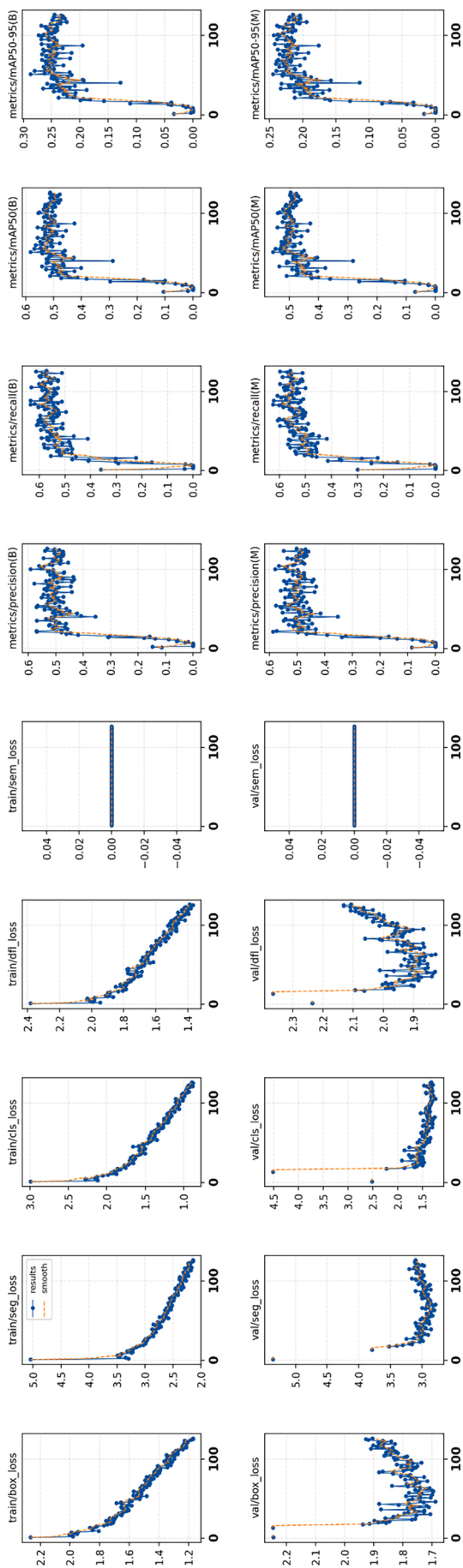


Fig. S2e. Training loss curves of the YOLOv11 model for fold 5