LAMAR UNIVERSITY

The Victor A. Zaloom Department of Industrial and Systems Engineering

MechGenius Creations

LAMAR UNIVERSITY

COLLEGE OF ENGINEERING

MEMBER THE TEXAS STATE UNIVERSITY SYSTEM™

Spring 2026 INEN 4385 IE Design

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Agenda

Topic	
Problem Statement & Approach	Cost Analysis
Background	Safety Considerations
LNVA Invasive Plant Control Methods	Environmental, Social, & Cultural Impact
Literature Review	Active Infestation from Field
Design Goals & Constraints	Local Data Collected
System Diagram	ML Implementation Skills
Design Alternatives	Model Evaluation Skills
Model Build	Design Goal Achievements
Final Design	Conclusion
Live Demo	Future Work
GIS Mapping	References
Design Verification	

Problem Statement & Approach

The Yellow Floating Heart is an invasive aquatic plant that threatens local waterways by spreading quickly and distributing into native ecosystems

Approach: Develop an AI model to detect Yellow Floating Heart and separate it from similar local plant species.

Prototype: Built and tested using local aquatic plant datasets.

Background

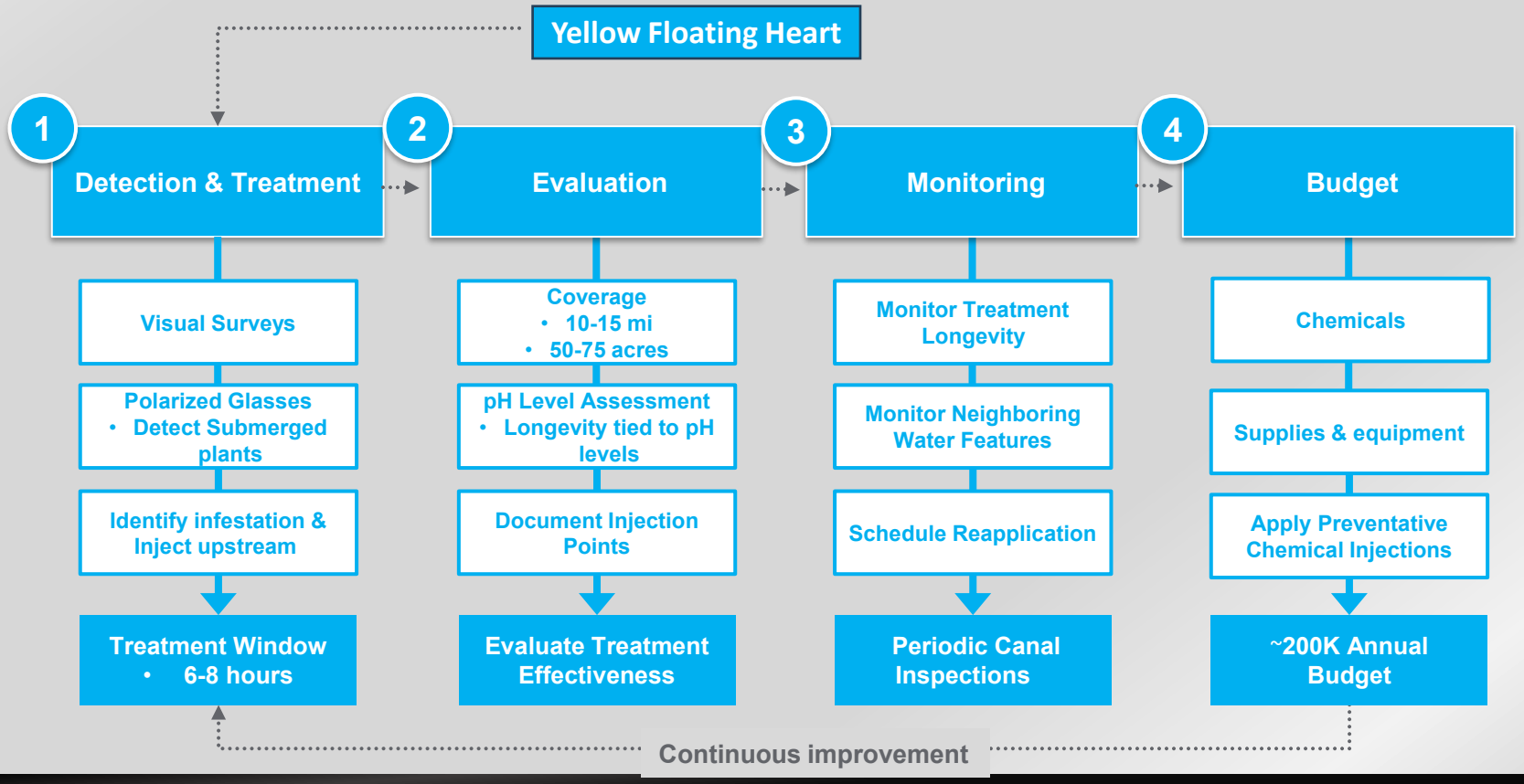
- LNVA manages hundreds of miles of waterways.
- Yellow Floating Heart spreads quickly covering 20-30% of infested areas [2]
- Can reduce water flow by up to 60%
- Removal costs $500-$2,000 per acre yearly.[3]
- Early detection is limited and inefficient.

Photo [1]

[Photo 1] : https://lnva.dst.tx.us/clean-rivers-program
[2] Texas Invasive Species Institute
[3] Rapid Response Plan

LNVA Invasive Plant Control Methods

A 4 steps process for continuous improvement & vegetation control budget



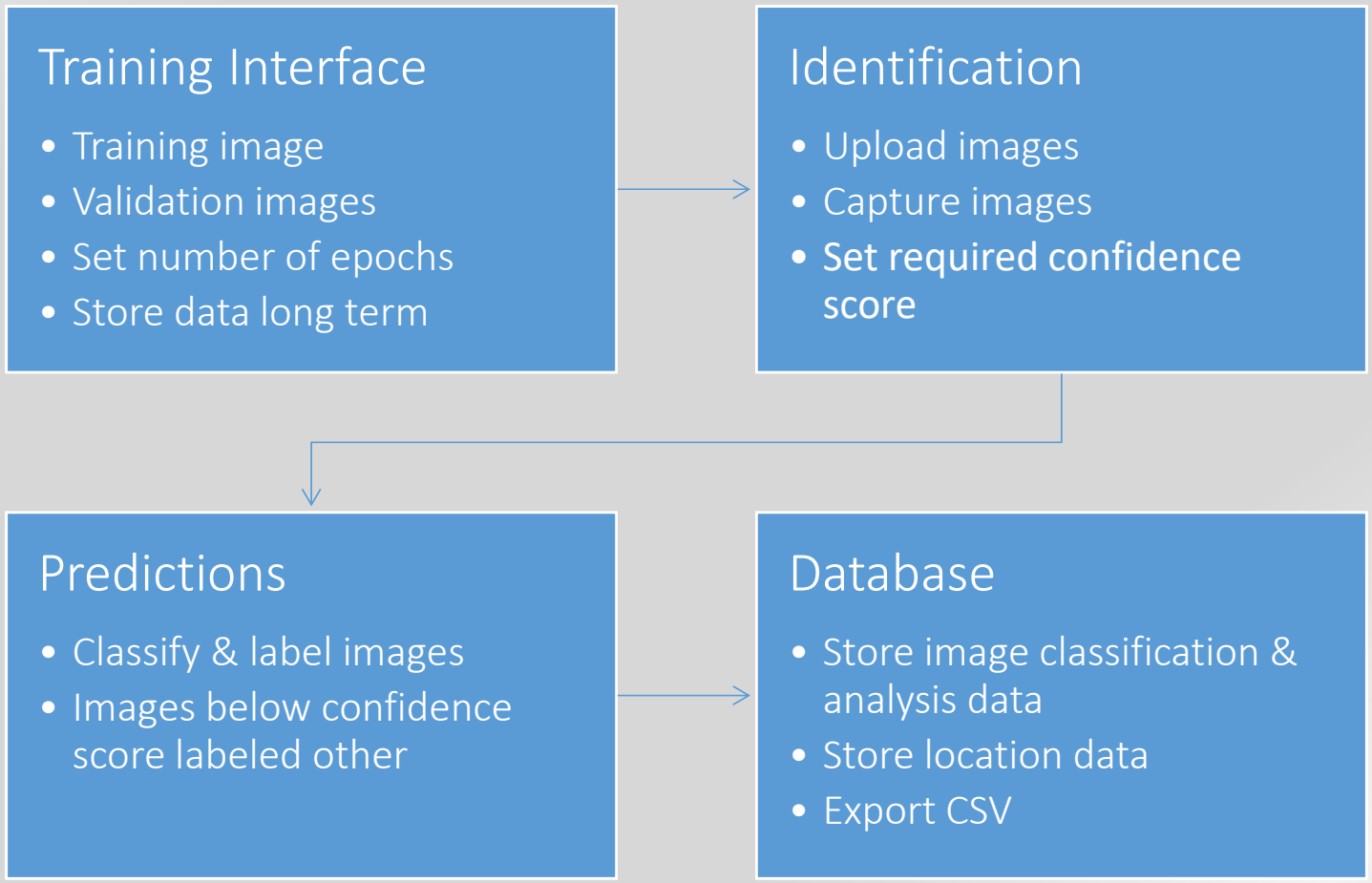
Literature Review

Methods	Pros	Cons
Herbicide Removal	Fast & effective for large areas	Can harm native species; repeated applications
Mechanical Removal	Physically removes plant with immediate result	High equipment cost; can spread fragments
Manual Removal	Most precise & Selective	Time-consuming; high labor demand

Design Goals and Constraints

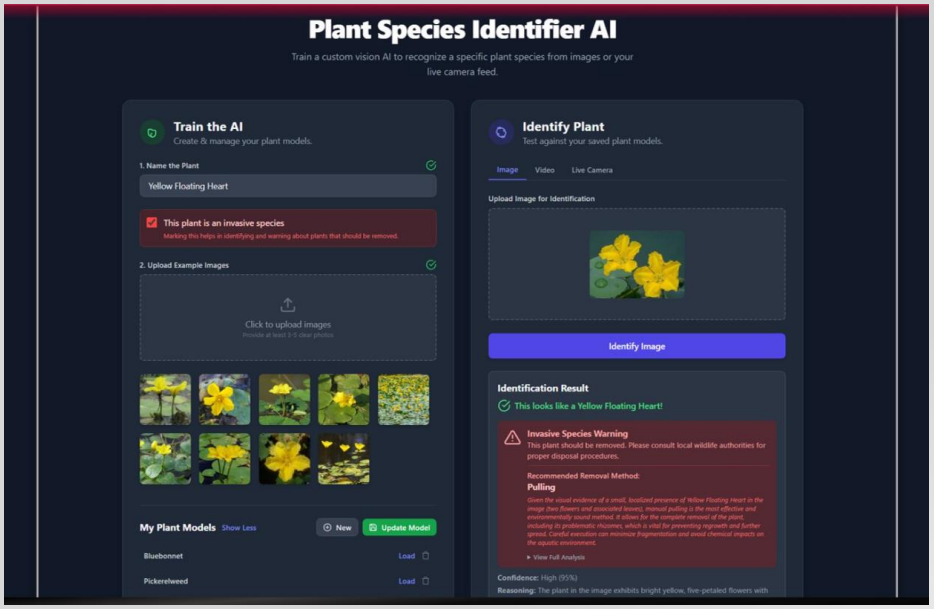
1. **Identification of invasive plant**
   - Acquisition of applicable training data
   - Over/under training
   - False positives and negatives
2. **Mapping of invasive plant growth**
   - Integration of GIS mapping and AI model
   - Scaling drone mapping to larger areas
3. **Scalable**
   - Self-contained & offline
   - Light weight

System Diagram



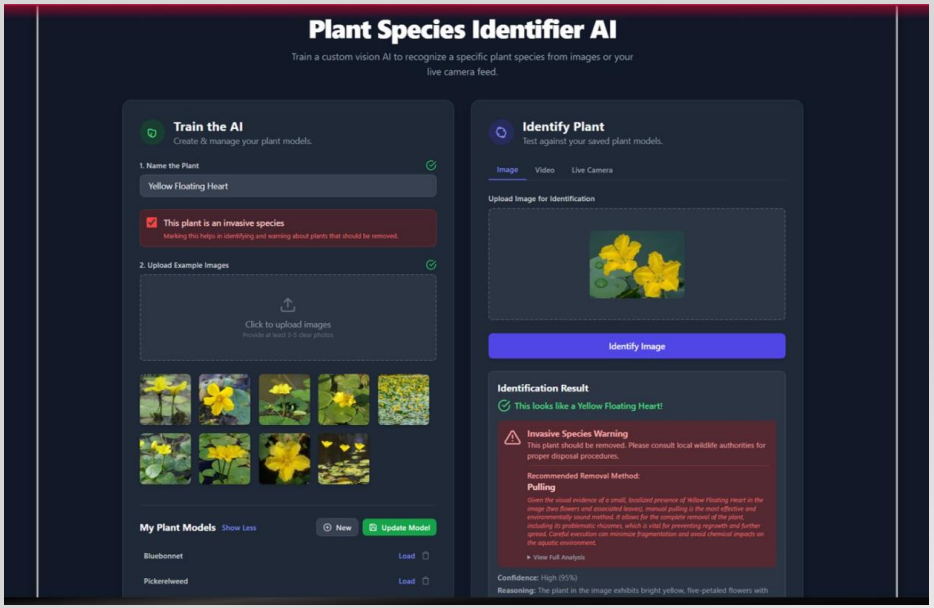
Design Alternatives - Google AI

- 95% Accuracy
- 9s Process Time
- Easy Data Analysis
- Free
- Assisted with Development
- Integrated with Google Tools (maps, gemini, etc)



Design Alternatives - Issues

- Limited Customizability
- Closed Source
- Difficult to Scale
- No Longer Free
- Slow Process Time
- Slow Development Time
- Google Updates Interfered with Development
- Limited Number of Images to Process



Model Build

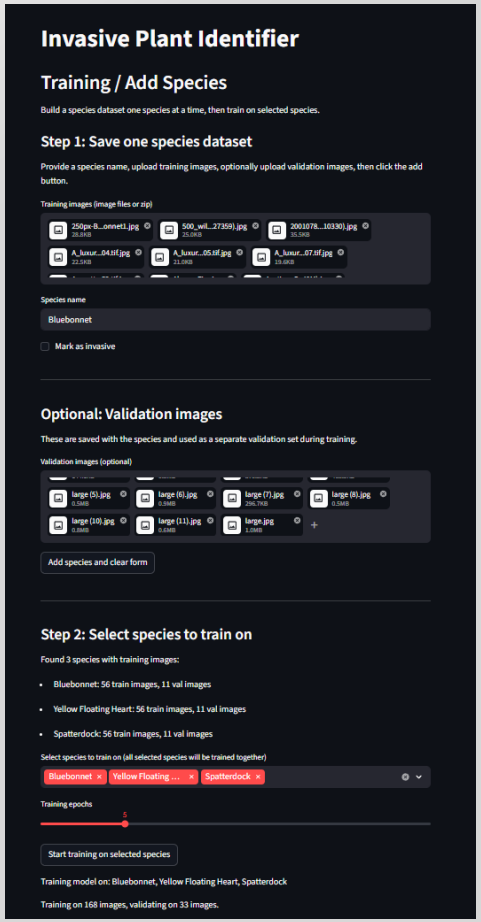
- Pytorch framework
- Open source
- Run on local computer or Streamlit
- Coding aid from Copilot & Qwen AI
- Available on Github (lparker25/Invasive-Plant-Identyfier)

Google AI vs Current Pytorch Build

Issue	Google	Pytorch
Customizability	Limited to Google AI	Freedom of Python
Public Access	Closed Source	Open Source
Scalability	Limited Dataset Size	Limited to Local Storage
Cost	Pay per Token & to Deploy	Free
Process Time	Avg 9 sec per image	Avg 0.032 sec per image
Image Process	~50 image limit	300+ images
Development	AI Coding Assistance	AI Coding Assistance

Final Design

Train



Identify

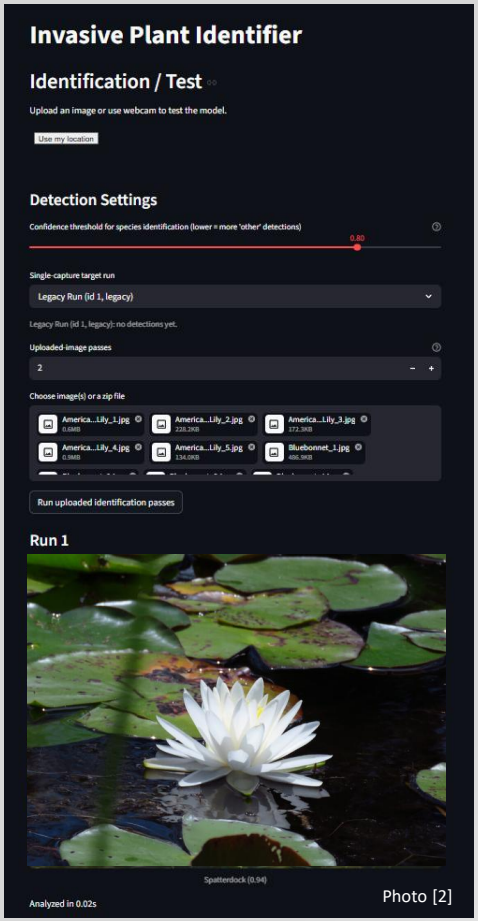
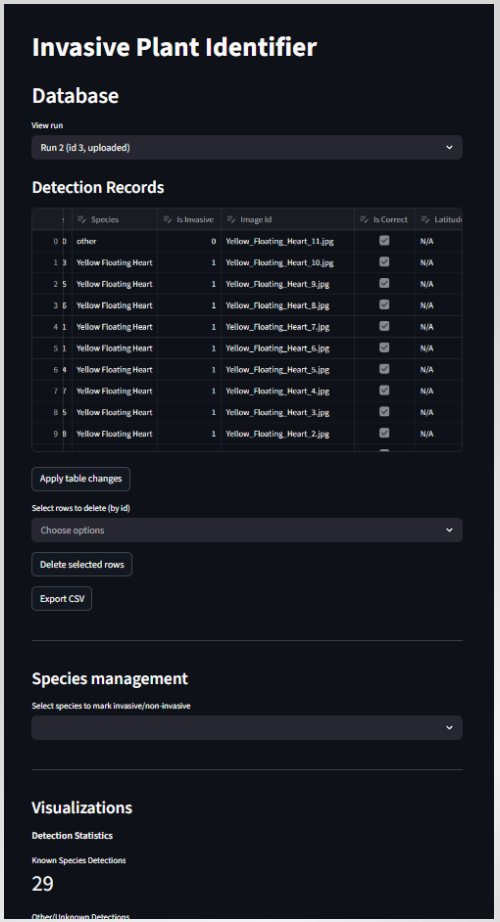
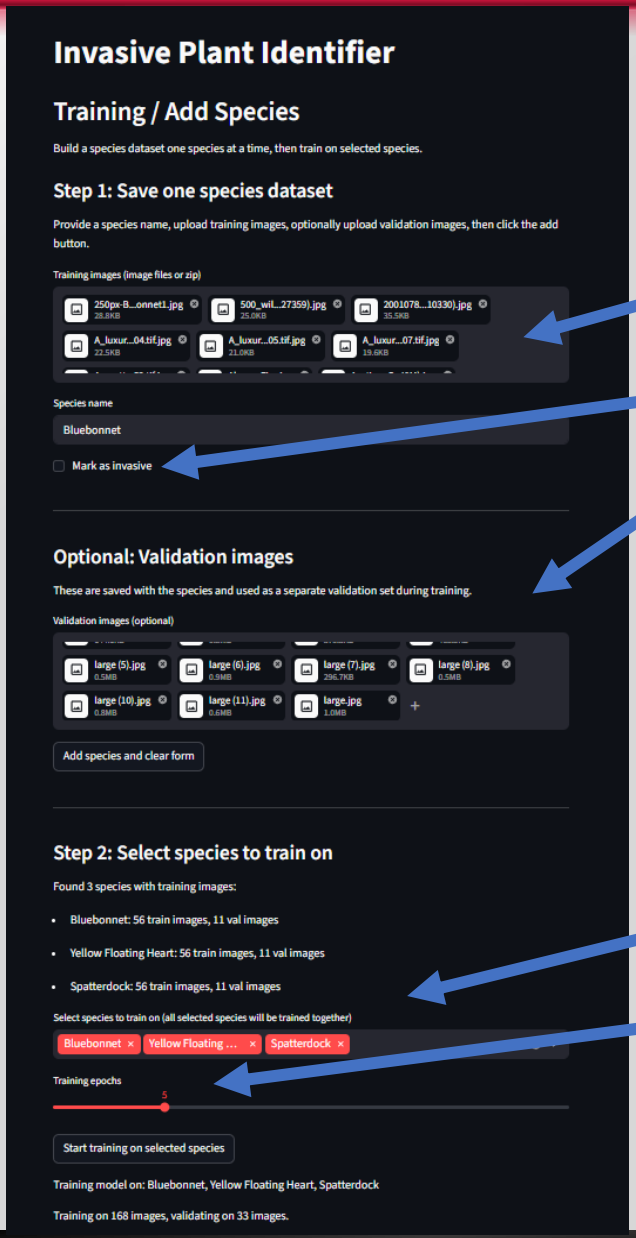


Photo [2]

Analyze





Training

- Add Species & Images
- Tag Invasive/Non-Invasive
- Add Validation Image Set
- Select Species to Train
- Set Epochs & Train
- Save Classifier

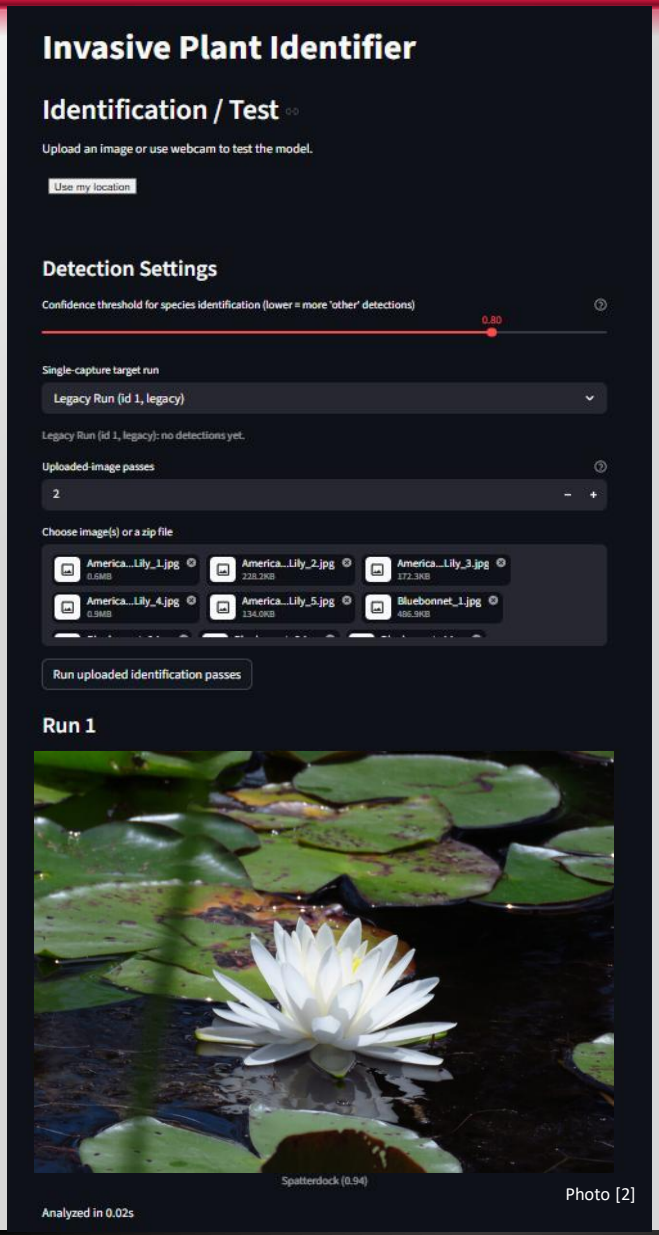


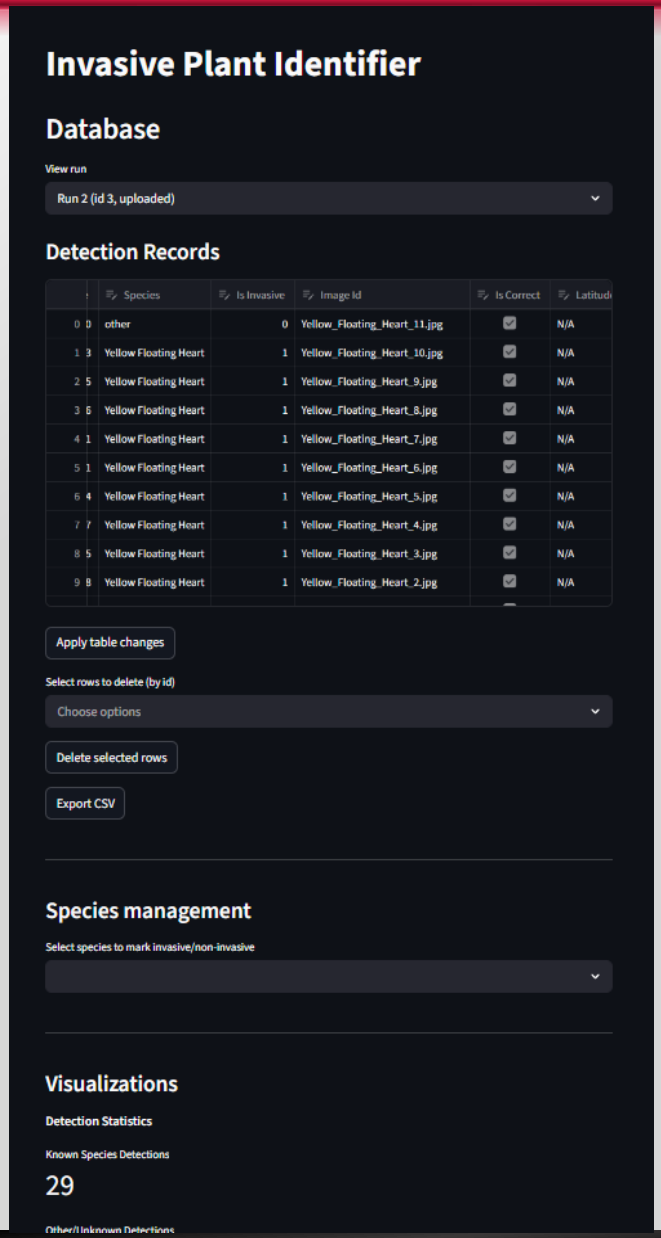
Photo [2]

Identify

- Upload Images/zip-file
- Set Confidence Threshold
- Set Number of Runs
- Analyze Uploaded Images
- Show Quick Summary

Photo [4]

Photo [3]



Analyze

- View Detections by Run
- Edit Detections
- Adjust Invasive Status
- Export CSV
- View: Analysis Time, Confidence Score, Invasive Status, Run Number, Image Name, Timestamp

GIS Mapping

- Geographic information system
- Map created via drone mapping mission [6]
- Interactive map showing the spread coverage of plants in a mapped area

Drone mapping mission plan

Composite orthomosaic image

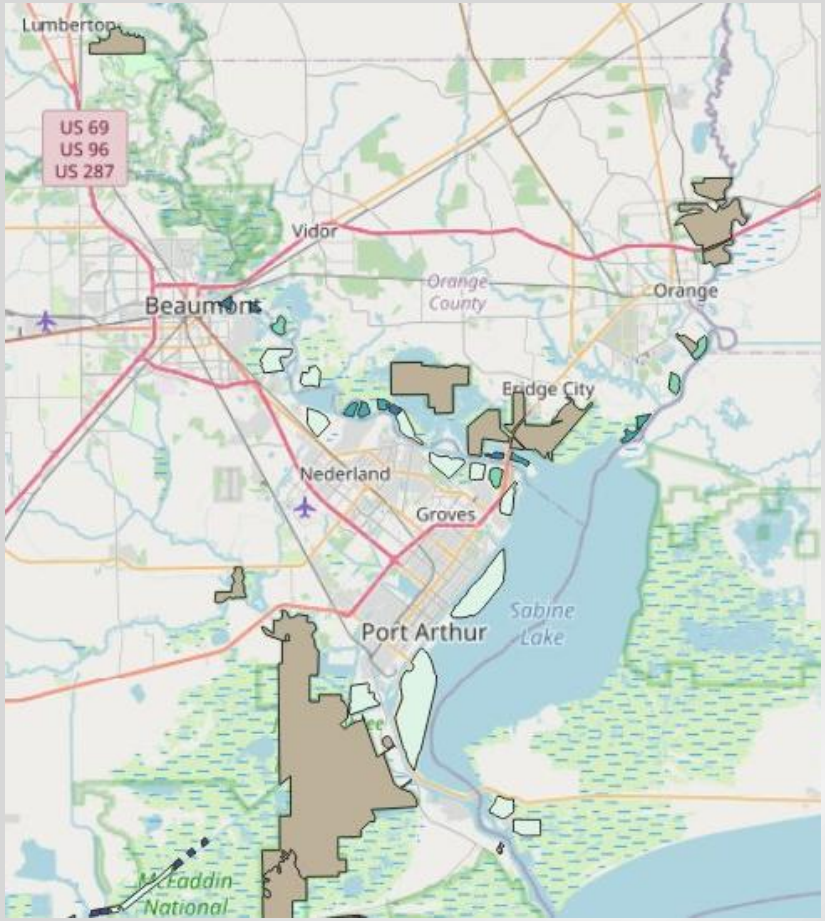
[6]: Drone data: Download Sample Drone Datasets. Drone Data | Download. (n.d.). https://www.esri.com/en-us/arcgis/products/arcgis-reality/resources/sample-drone-datasets

GIS Mapping

- Drone Mapping Mission Parameters
  - Flight altitude --> 200 ft
  - Image overlap --> 70%
  - Camera Angle --> 90° for 2D map
  - Speed --> 11 – 12 mph
  - Ground control points (GCP)
- Mission parameters determine the ground sample distance (GSD): The area on the ground that one pixel takes up

GIS Mapping

- Application of plant ID AI model onto drone mapping mission images to create GIS layer showing areas of invasive plant coverage
- Comparing new layers to previously collected data to monitor growth



[7]: Williams, K. (2022, October). Dredge Placement Areas (USACE). ArcGIS. https://www.arcgis.com/home/item.html?id=38fce486750846479cbf9a08859efd74

Design Verification – GIS Mapping

- Creation of orthomosiac image layer using ArcGIS
- GSD of approximately 3 cm/px with current drone and parameters
- Creation of more layers with collected data

Design Verification – Test Results

Average Accuracy	Average Process Time (s)	Average Confidence Score
79.82%	0.032	89.91%

Average	Yellow Floating Heart	Spatterdock
Accuracy	88.57%	81.82%
Recall/Sensitivity	90.91%	85.00%
Specificity	89.17%	80.43%
Precision	65.90%	65.00%

45 Different Trials

3 Different Datasets

6 species of plants were used for training. Full results are available; YFH and Spatterdock shown as primary targets

Cost Analysis

	Value	GB	Hours
Images/Month	100000		
Sec/Image	0.031		
Training Runs/Month	10		
hr/Run	0.062		
CPU Instance/hr	$0.10		
GPU Instance/hr	$0.90		
GB Storage/Month	$0.023	10	
GB Egress	$0.09	10	
Internal Ops Cost	$20.00		12

Reason	Cost
Inference Cost	$0.09
Training Cost	$0.28
Storage Cost	$0.23
Egress Cost	$0.90
Operation Cost	$240.00
Total Monthly Cost	$241.50

LNVA spend about $200k a year on vegetation control (chemicals, equipment, supplies)
Cost to run app is $2,898 a year

Safety Considerations

Risks	Mitigations
False Positives/Negatives	Use Larger diverse datasets + continuous model training
Misclassification of native species	Include native species in training + human verification step
Lighting/glare/overlap issues	Use image preprocessing + collect training data in varied conditions

Environmental, Social, and Cultural Impact

Impact Category	Yellow Floating heart
Environmental	Dense mats block sunlight and deplete oxygen, disrupting native aquatic ecosystems and making submerged portions difficult to detect in flowing water.
Social	Limits fishing, boating, and irrigation access for local communities while clogging water intake systems — requiring costly, ongoing management efforts
Cultural	Threatens Southeast Texas waterway heritage and traditions, prompting TPWD-led awareness campaigns to educate anglers and boaters on prevention

Active Infestation Samples from Field Inspection

Date Collected: 4/3/26 - Canal Site SW of Winnie, TX

Giant Salvinia

Plant Classification:

- Type of plant: Invasive
- Aquatic impact: Destroys ecosystems.
- Climate change risk: Worsening rapidly.

Oenothera Speciosa

Plant Classification:

- Type of plant: Non-Invasive
- Aquatic impact: Indirect and minimal
- Climate change risk: Minimal climate change.

Local Data Collected

Key details from the sources documented:

- 110 images collected
- 2 species
- JPEG format
- AI model performance results below

Average Accuracy	Average Process Time (s)	Average Confidence Score
77.67%	0.021	90.06%

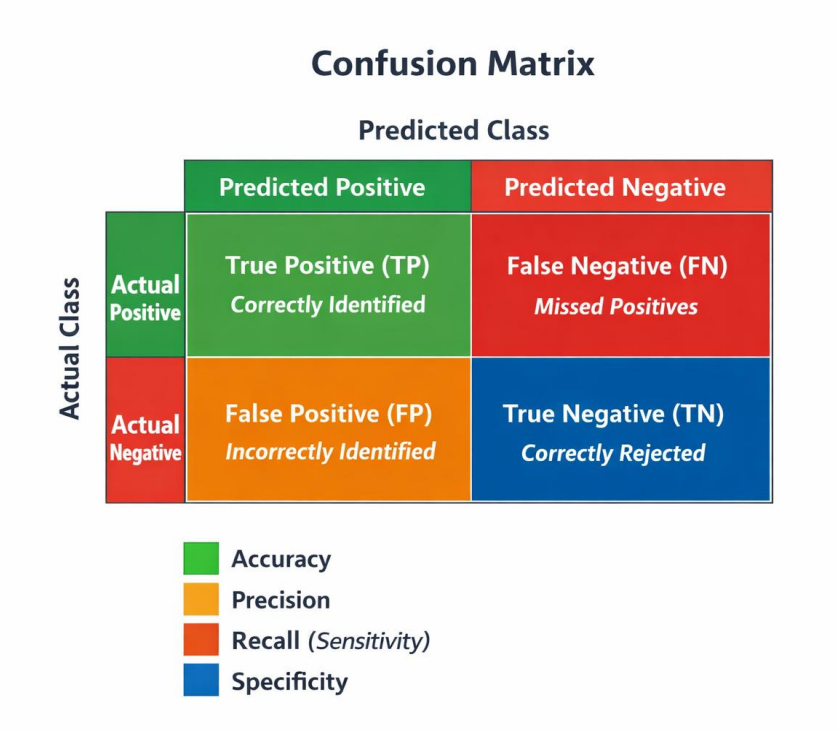
Average	Giant Salvina	Oenothera Speciosa	Yellow Floating Heart	Other
Accuracy	87.67%	97.75%	81.17%	88.75%
Recall	65.58%	96.43%	90.91%	10.00%
Specificity	100.00%	98.91%	80.18%	95.91%
Precision	100.00%	98.73%	31.60%	0.00%

ML Implementation Skills

- Built and trained a custom machine learning model for plant classification
- Implemented training pipeline using tools such as pytorch and streamlit
- Processed and labeled image datasets for supervised machine learning
- Tuned model parameters (epochs and confidence thresholds) to optimize performance

Model Evaluation Skills

- Used Accuracy, Precision, Recall, and Specificity to evaluate model performance
- Accuracy (**Accuracy = (TP + TN) / (TP + TN + FP + FN)**)
  - Accuracy is the overall correctness of the predictions
- Precision (**Precision = TP / (TP + FP)**)
  - Ratio of true positives to predicted positives
- Recall (**Recall = TP / (TP + FN)**)
  - The ratio of true positives to actual positives present in the data
- Specificity (**Specificity = TN / (TN + FP)**)
  - How many negative elements were truly negative



Design Goal Achievements

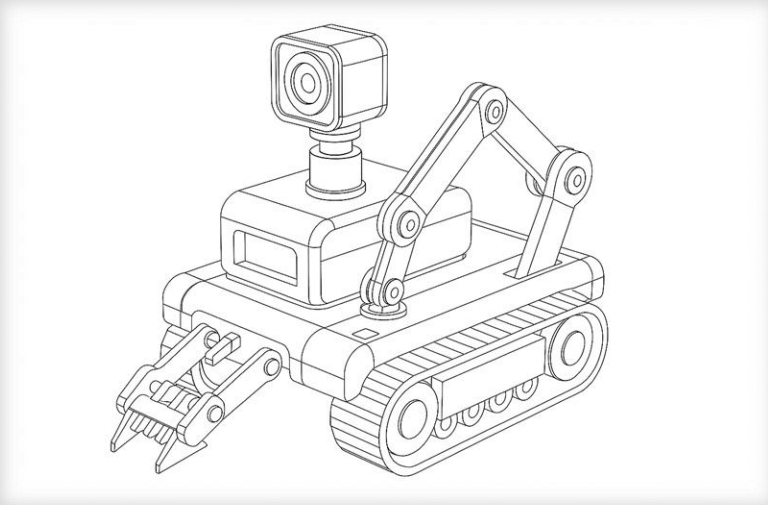
1. **Identification of invasive plant**
   - 79.82% Overall Accuracy
2. **Mapping of invasive plant growth**
   - Creation of drone mapping mission parameters and approximation of GSD
3. **Scalable**
   - Ran offline
   - Locally on Microsoft Surface 4 with intel i5

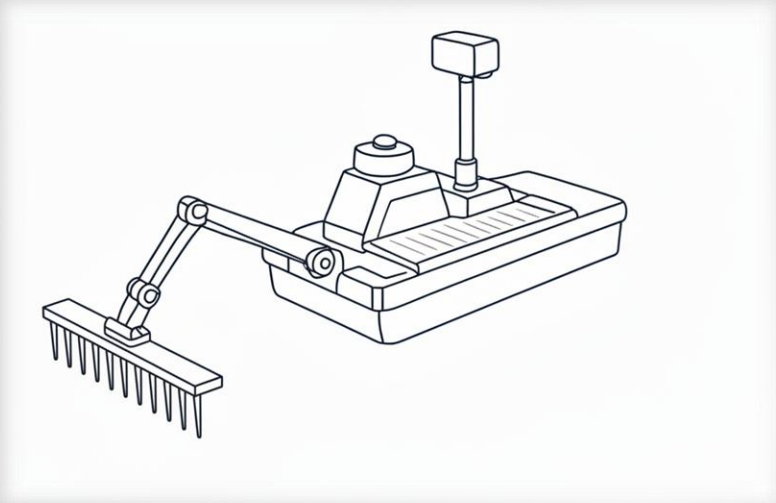
Conclusion

- Our AI based detection system successfully identified Yellow Floating Heart in local waterways.
- The model demonstrated strong performance with ~80% overall accuracy with high recall, making it effective for real-world detection.
- Integration with GIS mapping and drone imagery provides a scalable solution for monitoring invasive plant spread.
- This system offers a cost effective alternative (~$2.9K/year vs. ~$200K current control costs)
- This system could be improved by performing more verification tests to raise our precision value from ~65% which indicates some false positives.

Future Work

- Expand Dataset size
- Expand Field Data
- Improve UI
- Develop Removal Strategy
- Automate Training Process
- Integrate AI model with GIS mapping





Reference

[1] - Texas Parks and Wildlife Department. (n.d.). *Aquatic Invasive Species Prevention – Clean, Drain, Dry.* Retrieved April 2026, from

[2] - Texas Invasive Species Institute. (n.d.). Nymphoides peltata (Yellow Floating Heart). Retrieved April 2026

[3] - Rapid Response Plan for Invasive Aquatic Plants, Fish, and Other Fauna. (n.d.). *Cost and coverage analysis.* Retrieved April 2026.

[4] - Monitoring and water quality impacts of an herbicide treatment on an aquatic invasive plant in a drinking water reservoir. (n.d.). *Environmental impact of herbicide use.* Retrieved April 2026

[5] - Performance of unoccupied aerial application systems for aquatic weed management: Two novel case studies. (n.d.). *Herbicide effectiveness evaluation.* Retrieved April 2026.

[6]: Drone data: Download Sample Drone Datasets. Drone Data | Download. (n.d.). https://www.esri.com/en-us/arcgis/products/arcgis-reality/resources/sample-drone-datasets

[7]: Williams, K. (2022, October). Dredge Placement Areas (USACE). ArcGIS. https://www.arcgis.com/home/item.html?id=38fce486750846479cbf9a08859efd74

Photos

[1] - Lower Neches Valley Authority. (n.d.). *Clean Rivers Program.* Retrieved April 2026, from

[2] - waterous_flea. (2026, April). American White Waterlily. Retrieved April 2026,.

[3] - waterous_flea. (2026, April). Spatterdock. Retrieved April 2026,.

[4] - leekelai. (April, 2026). Water Fringe. Retrieved April 2026,.

[5] - Aldofo Leon. (April 2026). Giant Salvinia

[6] - Aldofo Leon. (April 2026). Oenothera Speciosa

[7] - Aldofo Leon. (April 2026). Oenothera Speciosa

Questions

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